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ROSS WINANS.

ROSS WINANS, who died at Baltimore, April 11th, was prominently identified with the early days of railroading in this country. He was born in Sussex county, New Jersey, in September, 1796, and went to Baltimore to reside in 1828. Among his first inventions were a patent friction wheel, with outside bearings, and the eight-wheeled car. In 1828 Mr. Winans exhibited a model rail wagon, weighing 125 pounds, loaded with ten "fifty-sixes" (560 pounds), and carrying two men, the total weight being 984 pounds; which was drawn with facility over a railway by means of a half-pound weight suspended over a pulley by a twine thread. The invention was tried in the presence of Charles Carroll, of Carrollton, and others, and considered a great success. In 1830 Mr. Winans removed permanently to Baltimore and became identified with railroad mechanics, in the days when the sole motor of railroads was horse power. After the invention of steam locomotives in England, by Stephenson, Mr. Winans was sent over by Messrs. Alexander Brown, Philip Evan Thomas, and others prominently identified with the Baltimore and Ohio Railroad, to investigate the new invention. After remaining one year, Mr. Winans returned with very satisfactory reports. While in England, it is said that Mr. Winans allowed his patent wheel to be used for experimental purposes, and his patent was ruthlessly infringed upon. Here he invented the "camel-back" engine, used for many years for surmounting high grades on the Baltimore and Ohio Railroad.

Mr. Winans began business as a locomotive builder in the firm of Gillingham & Winans, on Pratt street, Baltimore, about 1834, but after a short time bought out Mr. Gillingham and continued the business in his own name. The first locomotives built were "spear-wheels," but Mr. Winans soon substituted his own invention, constructing the "Camel," "Mars," and "Iris." After that he constructed over one hundred locomotives for the Baltimore and Ohio Railroad, and in that business accumulated the principal portion of his ample fortune. About thirty-five years ago, Major Whistler, who had been made by the Czar superintendent of all the railroads in Russia, wrote to Mr. Winans and invited him to take charge of the mechanical work. He declined, but sent out two of his sons, Thomas and William, both of whom have since made large fortunes, that of William being colossal in its extent. Messrs. Thomas and William Winans were practically trained to the business, having been head workmen in their father's establishment at Baltimore. At the opening of the civil war, in 1861, Mr. Winans ceased from active business, and never resumed his mechanical work afterwards. Of late years he led a quiet life, in the enjoyment of his fortune, which was estimated to be about $1,000,000.

B. J. BURNETT, M.E.

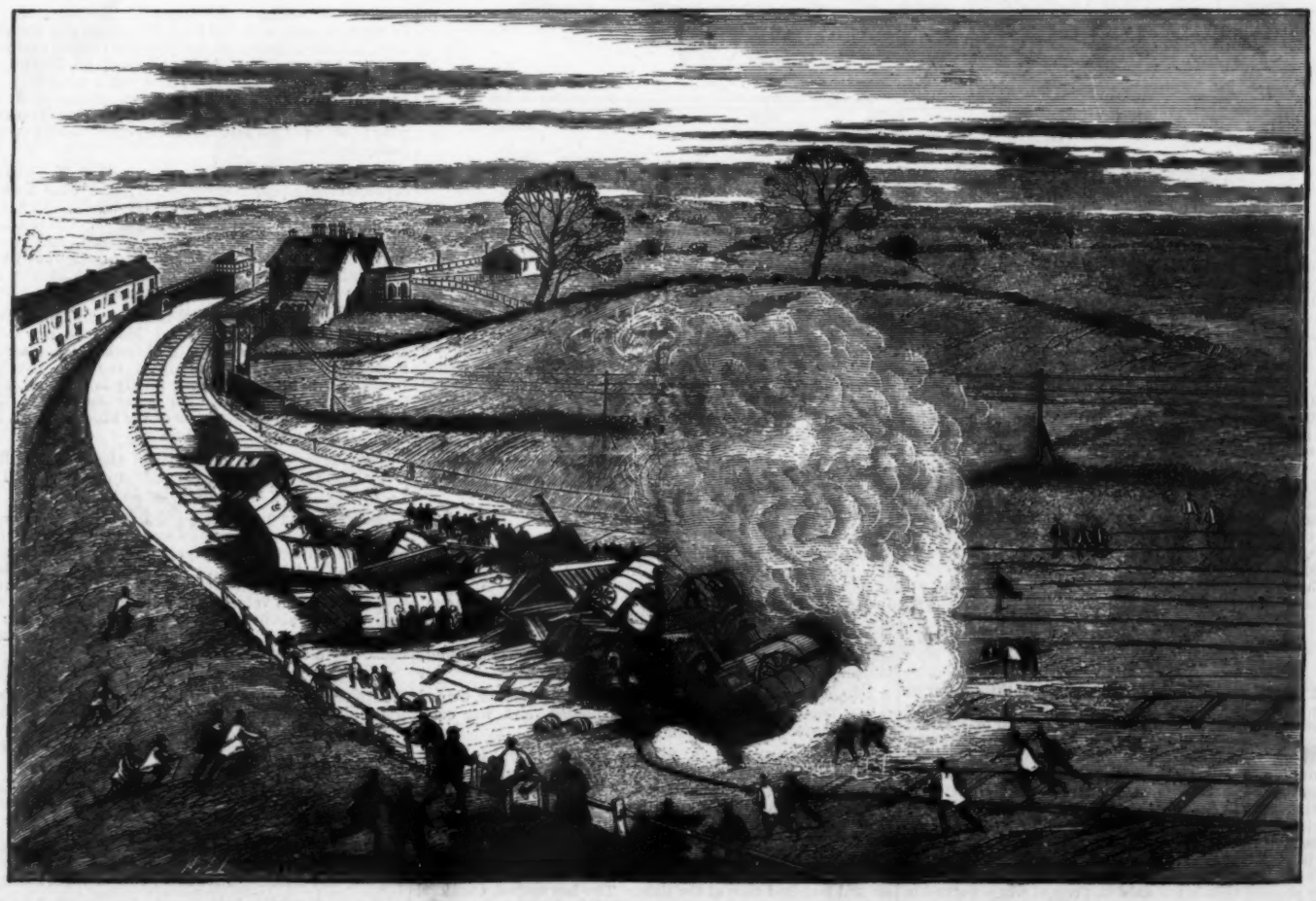
MR. B. J. BURNETT was born in 1809—the son of a Jersey farmer and a descendant of a family well known in the days of the Revolution. At the age of fourteen years Mr. Burnett was thrown upon his own resources through the death of his father, and having a taste for mechanics he found no difficulty in apprenticing himself to a trade. He developed while still an apprentice much executive ability, and while an apprentice he often had charge of a large force of hands. When but just out of his time he was placed in charge of many important enterprises, and among others was the foreman of the carpenter work on the Astor House. When the "Novelty Iron Works" of this city were started, he was appointed foreman of one of the most important departments, and for a period of over thirty years he was the trusted superintendent of two distinct departments. While in this connection he enjoyed the confidence and esteem of all those engaged in the establishment.

Mr. Burnett was a man of great mechanical genius, being the inventor of the "Independent Crane or Derrick," one of which is still in use at the "Novelty Iron Works," foot of Twelfth Street, East River, as well as a number of smaller steam cranes here and abroad. He was also the inventor of an improved system of ventilation, a sleeping car, a gold crusher, refrigerator, a hydraulic press for bending cold iron plates for plating vessels, besides many minor inventions of utility and value. From boyhood he took a deep interest in the mechanical arts, and for many years he was an acknowledged authority on all matters pertaining to this subject, and his advice was sought by scientific mechanics throughout the country.

As a man he was a gentleman of many true Christian virtues—self-made, he rose to distinction through his own innate energy and worth. He was loved and esteemed by all who knew him, and the primary cause of his death was overtaxation of his mind in his devotion to the mechanical arts. This over-tax resulted a few years since in paralysis, and latterly softening of the brain was developed, and the once strong man gradually succumbed, and on the morning of Sunday, March 25th, he breathed his last, regretted and mourned by all who knew him. Mr. Burnett was one of the original members of the association which located and settled the village of Mt. Vernon, N. Y., where he resided for more than a quarter of a century, esteemed and honored for his energy in the upbuilding of the village, for his kindness of heart, and his steadfast honesty of purpose.

AN ENGLISH RAILWAY ACCIDENT.

A SERIOUS accident occurred early on Sunday morning, the 25th March last, on the North Eastern Railway at Morpeth station to the night express from Edinburgh. It was timed to leave Edinburgh at half past ten, and pass Morpeth at twenty minutes past one. It appears that on Saturday night it was behind time in starting, and was twenty-six minutes late at Bilton. Between Bilton and Morpeth not much time had been gained, and in passing Morpeth it was twenty minutes late. It can hardly be said that the train passed Morpeth, for just outside the station, beyond the south end of the platform, the engine left the line, and a fearful catastrophe ensued. The night porter immediately rang the bell with violence, and as nearly all the officials are accommodated in a row of houses near by, the station-master and his assistants were immediately on the spot, but before they got the length of the platform many of the passengers were already out, and endeavoring to assist those who were screaming for help. No time was lost in despatching a messenger to the town, and by two o'clock Sergeant Robertson was on the spot. When he saw the serious nature of the accident he sent for Superintendent Acks and additional officers. The train consisted of an engine and tender, one or two fish vans, and a luggage van, eight or nine passenger cars, one a sleeping-car, and two goods vans, one in the middle and one at the rear of the train. Just at the south end of the platform a very sharp curve begins. There the engine left the rails, struck the down plates of the main line, and plowed its way across the six-foot way, tearing up rails and sleepers as it went for the length of sixty yards. At this point there is a junction with the Wansbeck Valley line. The latter half of the train not having come under the influence of the curve, the fish and luggage vans and two carriages swerved to the left. These having fallen over, the third and fourth carriages rushed with fearful force against the back of the tender, causing the engine to topple over across the Wansbeck line, and driving the tender's wheels into the earth three and a half feet deep. At the same time the two carriages that rushed against the tender were driven with such force that the front wheels were wedged literally through the metal back of the tender, and part of the woodwork was forced into the breach thus made. The second of these two carriages mounted upon the first, and another was pitched on to a coal wagon. The other carriages remained in position, but were all more or less damaged, except the guard's van at the end of the train. The sleeping car had its end stove right in. As soon as the injured passengers were taken out they were conveyed to the station-master's house. After working for some time at the ruins of the train the bodies of five persons were recovered. At first the work was carried on by the light of the roof lamps, policemen's lamps, and fires kindled on the banks. Hume Baumgartner, of Newcastle, arrived by a special train, and with Drs. Logie and James Logie of Morpeth, attended to the wounded. The slightly wounded were attended to and sent on south at five



ACCIDENT TO "THE FLYING SCOTCHMAN" AT MORPETH, ENG.

o'clock by a relief train from Newcastle. Through traffic was completely stopped, but by bringing trains from Tweedmouth, passengers and mails were sent forward by exchanging trains. Within an hour after the last body was taken out the permanent way on the up-way was laid, and the block of trains soon got partially cleared.—*Pictorial Times.*

NEW LOCOMOTIVE FOR STREET RAILROADS.

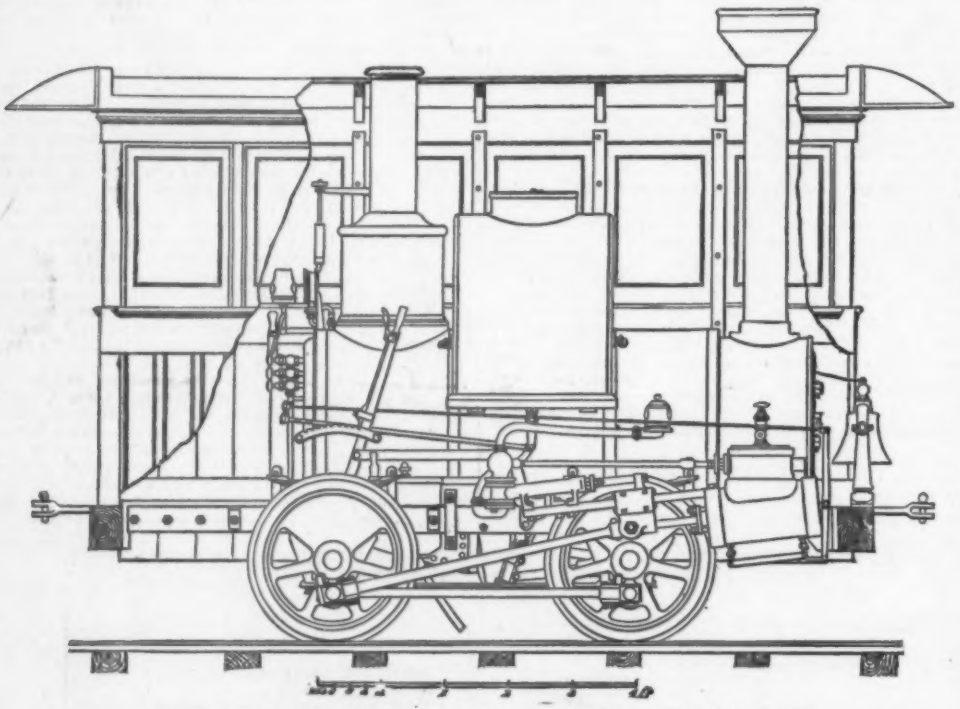
THE accompanying engraving represents a four-wheel locomotive, built by Messrs. Porter, Bell & Co., of Pittsburgh, Pa., for operating street and suburban railroads. The engine is represented with one side of the cab removed. It will be seen that it is simply a small four-wheeled tank engine, the tank being carried on top of the boiler.

Messrs. Porter, Bell & Co. believe that there are great objections to the use of a engine and car combined in one vehicle, and the best results are attained if the engine is made entirely separate from the car, and with the common form of locomotive boiler and machinery, differing from ordinary locomotives only in its proportions, and in such respects as the nature of the work to be done requires.

The engine we have illustrated has 7×12 in. cylinders, but this firms builds engines of this plan of the following three sizes:

Diameter of cylinders	6 in.	7 in.	8 in.
Stroke of piston	10 "	12 "	16 "
Weight in running order	9,000 lbs.	14,000 lbs.	20,000 lbs.
Length over all	11 ft. 6 in.	12 ft. 6 in.	15 ft.
Wheel base	4 ft.	4 " 6 "	5 ft. 3 in.
Capacity of saddle tank	150 galls.	300 galls.	375 galls.
Diameter of driving-wheels	28 in.	30 in.	36 in.

The engraving represents the construction of these engines very clearly. The whole machine is inclosed so as to resemble a street car, and it thus takes up less room than horses, both on the track and for stable accommodation. The room required for a pair of horses is 14 ft., whereas the engine occupies a space of only 12 ft. 6 in., and as the engines run faster and need not be laid up for rest, one engine will do more work than several pairs of horses, so that much less room is



NEW LOCOMOTIVE FOR STREET RAILWAYS.

required for shelter for the engines than for the horses; and owing to the greater speed of the engines not so many cars are required, and also less room for storing and sheltering them.

We are informed by Messrs. Porter, Bell & Co. that the New Orleans City Railroad is operating engines of this plan with 7×12 in. cylinders, and with others having 8×16 in. cylinders, but with a two-wheeled "pony" truck. The 7×12 in. cylinder engines make a trip of six miles, and return regularly in eighty minutes, hauling from two to ten loaded streets cars, and when necessary can easily haul the same load at 20 miles per hour, not including stops. No inconvenience is experienced from smoke or noise, and the work is done at something like one-third the cost of doing it in a much slower and less convenient manner by mules, which have heretofore been chiefly used in New Orleans for this service.

Some accurate detailed and trustworthy data showing the relative cost of animals and steam power on the road referred to, and also the nature of the business, would have great interest and value at the present time, when the subject of the use of steam on street railroads is attracting so much attention.—*Railroad Gazette.*

[THE LOCOMOTIVE.]

PITTING OF BOILER PLATES.

IF you will allow me space in your valuable little paper to ventilate a pet theory on the subject of pitting of boiler plates and feed pipes, it may draw the attention of some of the inspectors of your company, and bring about a discussion of this, to me, very interesting subject. The conditions that seem favorable to this action are varied, but two principal ones seem to be generally noticeable: they are a lukewarm state of the water in contact with the affected surfaces, and a lack of circulation; as in feedwater pipes of wrought iron where the current is sluggish and the water tepid, and in parts of boilers where the water may be in the same condition, and this, too, with water of unimpeachable purity. We generally suspect that some acid is present when corrosion goes on rapidly, but may not oxygen, that has been sometimes called the acid maker, after all be the insidious foe? I have often noticed in open vessels of tin, glass, and, perhaps, iron, where water was being slowly heated, little globules of air or gas adhering to the bottom and sides, and have noticed that considerable agitation sometimes fails to break them, and this, too, under little more than atmospheric pressure. May we not suppose that such a thing might happen in the cases cited, and that these little globules contain the gas in favorable condition of moisture and temperature to act rapidly on the metal, and that having eaten a little pit, and exhausted its oxygen, it leaves the pit filled with oxide of iron? A slight change in the temperature or, perhaps, a very decided one now contracts the metal and the oxide is cracked off, leaving the iron in a good condition to attract the next little globule to the same place, which in turn does its work, and so on till a hole is bored through.

The fact that cast iron pipes, that are granular and homogeneous in structure, are not attacked in this way seems to favor the theory that a lack of these qualities and of chemical uniformity in wrought iron pipes and plates is the true solution. Still cast iron marine jet condensers are often entirely changed in their lower parts where oxygen would be likely to settle, it being heavier than the vapor of water under the same conditions of temperature and pressure. I have heard of a case where the metal could be cut away with a knife, and appeared to have about the consistency of blacklead, but the action was uniform, and had no enlarged or corroded appearance as wrought iron oxide has.

An interesting case was observed by the writer in a New England city that had lately been supplied with water of remarkable purity from a mountain lake, and it was maintained in the distributing pipes at a very high pressure. A steam boiler that was fed directly from these pipes appeared to be suffering from oxidation, so much so that a suspicion of the presence of an acid was raised, but an analysis, by a competent chemist, of a quantity of water drawn from this boiler that had been run two weeks without blowing out, revealed the fact that no acid was present, but that the water contained an excess of oxygen, and that the solid matter was oxide of iron. This must have come mainly from the substance of the boiler, as the mains were cement-lined pipes, and only a very short wrought iron pipe was used to make the connection. This was a horizontal tubular boiler, worked to its full capacity, and the circulation was therefore good within it, and the corrosion was probably uniform, or nearly so. But a tubular feedwater heater in another establishment exhibited a most remarkable sample of pitting, although the pipes were coated, or galvanized as it is called, and this was done in a very short time, and a second new set of pipes was put in to be replaced with brass ones. The wrought iron warm-water pipes in a hotel using the same water were soon replaced by brass ones. This is only a small part of the circumstantial evidence that I have observed, all of which points to my pet theory, and I should be pleased to hear from your experts on this subject.

S. N. H.

(Continued from SUPPLEMENT No. 72.)

BOILER EXPLOSIONS, FROM SEPTEMBER, 1876, TO APRIL, 1877.

Locomotive.—The boiler of a locomotive on the Alexandria, Manassas, and Orange Railroad, in Virginia, exploded at Abington, Tuesday, Oct. 31, killing the fireman, J. W. Jetter, and the engineer, Robert Wilson, and Gordon Fugua, a youth, was badly scalded. This was the first trip of the fireman and the engineer. All the window glass in the neighborhood was broken. The steam-gauge, when found, indicated a pressure of 160 pounds.

Portable.—About 5 o'clock P.M., a portable boiler, owned by R. Jennings, of Petrolia, Pa., exploded, and was completely destroyed, being torn into fragments.

Rolling Mills.—At 11.30, on the night of Nov. 14, a most horrible disaster happened at the Union Rolling Mills, located on the corner of Ashland and Archer avenues, Chicago, in the extreme southwestern portion of the city. Two boilers exploded simultaneously with a terrible detonation. Four men, Michael O'Leary, Patrick Cain, Michael Galvin, and Patrick Connors, were, so far as could be learned, the only ones injured, although the works were in full operation with several hundred men at the time. The last named, Connors, is the only one that is seriously and, it is thought, fatally injured. The *débris* of the shattered boilers was thrown 500 feet through the air, completely demolishing four buildings southwest of the mills, but with what damage or what loss of life is unknown at present writing. The main building of the works is a most complete wreck, entailing a loss upon the company of, at least, $25,000.

Steamboat.—By the explosion of the boiler of the steamer Minisceongo, Nov. —, on the Ashley river in South Carolina, the captain and four of the five men who composed the crew were blown to pieces, and the vessel destroyed. The engineer only escaped.

Saw Mill.—The boiler of George Donner's saw mill in Austin township, Sanilac county, Mich., exploded Monday, Nov. 20th, killing John and Charles Snider, and a man named Rea.

Wooden Ware Works.—On the 7th of December the middle boiler of a battery of three, at the Detroit Wooden Ware Works, situate on Wright street, Detroit, exploded, demolishing the brick boiler house and boiler chimney, 75 feet high, killing one and injuring two other persons. The jury rendered the following verdict: "That the said August Mackrodt came to his death by a blow-out of a defective boiler at Frost's Detroit Lumber and Wooden Ware Works on the morning of December 7. We, the jurors, do further say that the blow-out was caused by a steady pressure of steam on the defective boiler head, there being sufficient water in the boiler at the time. Furthermore we say that the boiler was defective, inasmuch as the head was cracked more than half way through on the inside, and more than half way around, inasmuch as some of the stays were slacked by the head being driven in to meet the short flues, inasmuch as some of the stays were broken, and some of them cracked, and inasmuch as the boiler was somewhat aged.

Saw Mill.—Daniel C. Jones, Amos Marsh, and William Marsh were killed, Thomas Davis and Jos. Phillips seriously injured, by the explosion of a portable saw mill, near Oak Hill, Jackson county, on the afternoon of November 29. Two others were slightly injured.

Shoe Factory.—About 7.10 o'clock, December 8, people in the vicinity of the "Big Tree," on Boston street, Salem, were startled by a dull explosion in the rear of the large shoe manufactory of Winslow & Rogers, No. 86, on that street. An investigation proved it to have been the explosion of a patent sectional boiler in the basement of the shoe factory. Inquiry at the scene of the disaster established the fact that there had been no loss of life, and only four were injured. The boiler was a new one, and the maker, Mr. John H. Mills, of Boston, was present in the boiler room with Messrs. Winslow & Rogers, testing the boiler. It had stood the test with water, and steam had been just let on. About ten minutes before the explosion, the gauge showed a pressure of 90 pounds. Mr. Mills and the two members of the firm stood directly in front of the end of the boiler, when it blew out with a tremendous concussion. The boiler was a sectional one, and was made at the Walworth ironworks, Boston, and was the invention of Mr. John H. Mills of that city. The explosion is stated to have been caused by a probable defect in the cast iron "water-back," or at least this is the explanation vouchsafed by Mr. Mills, anxious in the midst of his agony to defend his invention.

Dwelling.—The range in Mr. Robert Bonner's residence in Angell place, blew up on the morning of December 10, injuring Mr. Bonner quite severely. Mrs. Bonner had a leg broken, and was otherwise hurt.

Bakery.—A little before 7 o'clock, on the morning of December 11, the boiler in Files & Jones' bakery, on Pickering square, Bangor, Me., exploded with a loud noise. Steam was just being put on when, without any warning, the boiler burst in several places, the bricks flying in every direction, and the water pouring into the shop. The damage will amount to about $1,000.

Warehouse.—The boiler house of the American Transfer Company's station at Oil City, Pa., took fire December —, 1876, and the boiler exploded and was thrown against an iron tank containing about 15,000 gallons of oil, bursting the tank and setting the oil on fire. There was a total loss of 35,000 barrels of oil and five iron tanks, two owned by McWhinney Brothers, two by Cochrane, and one by the Transfer Company; also five Erie Railroad boiler cars, footing up $200,000; partly insured.

Saw Mill.—The boiler in a saw mill at Texarcana, Ark., exploded Monday, December 11, and nine men, named Chauncey Beach, James May, W. White, Nicholas Rosebaugh, Ed. Griffin, George Green, Tip Stewart, George Jackson, and Fred Williams, were killed, and two colored men named Custer and Johnson were dangerously wounded. The mill, which was one of the largest in the state was running full power, and was totally destroyed. Loss $8,000.

Copperas Mine.—The boiler in the engine house at the copperas mine on the Greenpond Mountain, ten miles from Dover, N. J., exploded Dec. 12, blowing the house to pieces. Four men were in the building at the time, two of whom were instantly killed, another fatally injured, and a fourth terribly mutilated, both eyes being destroyed. John A. Clarke, the engineer, was one of the killed, and his body was blown a distance of 300 feet away.

Cotton Mill.—The steam boiler of the cotton mill at Griswoldville in Coleraine, gave out Saturday night, December 14, the rent being about 16 inches in length.

Saw Mill.—At 9 o'clock on the morning of December 18, the boiler in D. C. Purman's saw mill at Monroeville, Ind., exploded with terrible force, although there was only 50 pounds of steam pressure on at the time. The top of the boiler was lifted from its position and hurled through the roof with fearful velocity. John Goley, foreman, was seriously injured about the head, but not fatally. The roof was blown to atoms. The explosion is supposed to have been caused by a defect in the boiler.

Packing House.—On the evening of December 18, about 7.30 o'clock, the boiler of Slavens, Mansur & Co's packing house at Kansas City, Mo., blew up with a terrible report, and blew Jerry Mack, the foreman, through the door, a distance of about 50 feet. The head of deceased was found nearly 30 feet from the body.

Tug Boat.—The boiler of the tug boat, Jacob L. Neafie blew up December 20, off the Highlands, N. Y., and the captain, steward, and a deck hand were killed.

Woolen Mill.—Two boilers exploded in the Catskill, N.Y., Woolen Mills, Thursday evening, December 21, wrecking the engine, and scalding three men, two of them fatally.

Barn.—A terrible boiler explosion occurred in the street car barn on Niagara street, Buffalo, December 21. A part of

the boiler was thrown over 400 yards into the canal. Fortunately there was no one in the barn at the time, the only damage being to property to the extent of about $8,000. It is alleged that low water in the boiler was the cause of the explosion.

Tug Boat.—The boiler of the tug-boat Port Smith, Captain Riehl, exploded in Baltimore Harbor Friday morning, December 29. The son of the captain, aged 7, was killed, Henry Black, engineer, and Philip Hasnough, fireman, were severely bruised and scalded.

Saw Mill.—The boiler of a portable saw mill owned by Nott & Co., exploded near Marietta, Ohio, January 5, and severely injured four wood-men, one of whom will probably die.

Saw Mill.—The boiler in Lawton's shingle mill near Verona, Mich., exploded January 10, killing three men. Others were injured.

Thresher.—By the explosion of a boiler attached to a threshing machine on the farm of Albian Bradbury, at Bloomington, Minn., on Tuesday, January 16, John D. Layman, Lucius Layman, his son, and Geo. Bradbury, a lad of thirteen years, were instantly killed.

Sugar House.—An explosion of a converter, Saturday, January 20, in the sugar house connected with the starch company's works at Glen Cove, L. I., killed Dr. Willie, the chemist, and Adolph Grimm, and badly hurt Henry Keck and Geo. Crane.

Saw Mill.—On Monday afternoon, January 22, at Ormanville, Iowa, near the Davis County line, a portable steam mill was in operation, sawing railroad ties, when an explosion occurred in consequence of the giving-way of the crown-sheet. Mr. B. B. Stevens, owner of the mill and a prominent citizen of Wapello County, was standing in front of the engine, and was blown to shreds. He was forced through the shed surrounding the engine, 100 feet, into the creek. One arm was carried about sixty feet beyond his body; one leg was carried in another direction, and his heart and bowels in another; while one leg was in shreds, twined around his neck. One boot was lodged in a tree thirty feet from the ground, and forty feet from the boiler; and his clothing was entirely stripped off, except one boot. His vest, which contained a fine watch in one pocket, cannot be found. His pocket-knife was found with the blades and springs broken, and sides of the handle gone. The engine and boiler were thrown about 100 feet, a perfect wreck. One of the hot grate-bars was thrown through the walls of a house 60 yards away, where it set the premises on fire, the inmates narrowly escaping a horrible fate. Several workmen who were near the engine were injured, but not seriously.

Saw Mill.—About 8 o'clock on the morning of January 22, a fearful explosion occurred at Ink Bayou, nine miles northeast of Little Rock, Arkansas. The boilers in Griffiths & Hyck's shingle factory and saw mill exploded. Three men were killed and several dangerously injured. The killed are Benjamin Smith, from Georgia; James McGinness, from Toledo, Ohio, and a colored man named Andrew Lewis. The largest part of the boiler, including the head, was blown several rods through the forest, cutting down trees 12 inches in diameter. The mill was one of the finest in the State.

Brewery.—A terrible boiler explosion occurred in the large beer brewery of David Haas at Buffalo, N. Y., about noon of January 23, killing Gustavus, and fatally scalding Herman Haas, both sons of the brewer. Cause unknown.

Saw Mill.—By the boiler explosion, Friday, January 25, in Joseph Goff's saw mill, near Eaton, Ind., Samuel Saunders, a fireman, was instantly killed, parts of his body being found 500 yards from the engine. Walter Cunningham was blown to pieces. Samuel Younce was terribly scalded and his legs and arms broken. Joseph Goff was badly scalded. Three other men were severely but not fatally injured. Younce and Goff have since died. The cause of the explosion is not known.

Bleach.—A tank of chemicals used for cleaning rags exploded January 27, at Bronxville, Westchester County, and Thomas Wilson and his two sons, Fletcher and James, were severely injured.

Printing House.—The boiler of the *Daily News*, Chicago, exploded February 10, demolishing the two-story extension of the building in which it was situated, ruining a folder and injuring four cylinder presses to some extent. Two or three folders were scalded and bruised. The precise cause of the explosion could not be ascertained. It appears that the regular engineer connected with the establishment left for home at 6 o'clock, leaving the premises, including the "buster," in charge of a boy, whose duties seem to be multiform. Besides attending to the boiler and engine, he had also a press to feed, and it is surmised that while he was thus engaged, he allowed the boiler to become overheated, and thus a sudden injection of cold water caused the rumpus.

Saw Mill.—The boiler in Harrison Jones' saw mill, nine miles from Noblesville, Ind., exploded on Saturday morning, February 10, killing Pleasant Gillam and James Page, and injuring Marion Stewart and Thomas Jackson so badly that they have since died. Three other men were slightly injured.

Ferry-Boat.—The ferry boat, Jones, from Bayou Goula to Plaquemine, La., was blown up by the explosion of her boiler, Thursday, February 15, and six persons were killed.

Barrel Factory.—By the explosion of the boiler in the Clifton Barrel Works at Pomeroy, Ohio, on the 21st of February, four persons were killed and twelve wounded. A boy was blown 70 feet into the air, but escaped unhurt.

Saw Mill.—By the explosion of the boiler of a portable saw mill at Alvord, Ind., on the 22d of February, four men were instantly killed and four others severely injured.

Hotel.—A boiler in the laundry of the Bangor House, Bangor, Me., exploded on Saturday afternoon, February 24, scalding three girls, but not seriously. The damage will foot up about $1,000.

Saw Mill.—The boiler of Kocher & Baker's saw mill in Huntington, Ind, exploded March 1, killing Samuel Hale, and fatally wounding Frederick Allen, Joseph Brown, James Collins, W. Fraser, and John Crocker. The building was shattered to atoms.

Locomotive.—The boiler of an eastward bound passenger train on the Northwestern Railway exploded as the train came into the depot at Sterling, Ill., March 18, killing engineer Wm. Watson, station keeper Samuel Walcott, and a fireman, name not given. The reason of the explosion is believed to be that the boiler was out of water.

Saleratus Works.—J. Monroe Taylor's saleratus factory, a seven story building, running from 24 to 30 Sackett street, South Brooklyn, was burned March 11; loss $140,000, insurance $95,668. When the walls fell in, a boiler exploded and blew the walls out of the house, No. 17 Union street, occupied as a grocery by Dennis Leahy.

Saw Mill.—A boiler exploded in the saw mill of Hunter Brothers, five miles east of Worthington, Ind., March 16, killing twelve persons and wounding seven, all that were in the building. The mill ground corn on Fridays, and was trying a new set of corn burrs, and the day being wet the neighbors had gathered in. The names of the killed are: A. Van Derventer, James Hunter, John Wilkie, John Spitz, a son of G. W. Bender, a son of Geo. Ray, a son of Wm. Bunter, a Mr. Hamilton, a son of Henry Sarver, a son of Jacob Brubaker. The wounded are: John Brubaker, Alfred Hunter, A. Hosh, a son of George W. Bender, Wm. Bland, a son of James Hunter, and a man whose name is unknown.

Locomotive.—An engine exploded at Keyser, on the Baltimore and Ohio Road, Saturday, March 17, killing the fireman and scalding the engineer, conductor, and brakeman severely.

Dye Wood Works.—About 9 o'clock, March 23, the residents of East Boston, in the vicinity of the Boston Dye Wood and Chemical Company, were startled by a loud report and a tremor of the ground as if an earthquake had shaken the island. The cause of the commotion was the bursting of a large copper still at the works of the above-named company, situated on Border street. Four men were seriously injured by the escaping steam. The copper still which exploded had been in use eight or ten years, and was registered to stand 100 pounds to the square inch. It was provided with Locke's patent regulator or safety valve, permitting a pressure of but 30 pounds to the square inch. There was a logwood mash in the still at the time of the accident. The explosion, which took place without the slightest warning, is attributed by the company to the stopping of the steam vent in the still; to regulate which was the business of the man fatally injured.

The following cases show that steam, in small quantities, is not to be trifled with:

Dental.—The Cleveland *Herald* says: A miniature boiler explosion occurred January 23, on the West Side, by which considerable damage was done. Dr. I. Brown, a dentist, occupies rooms over Hawley & Keeley's drug store, No. 141 Detroit street. He possesses a little copper boiler holding nearly a pint. This he fills with alcohol and heating it over a lamp throws the steam by means of two small tubes upon a gas jet, to be used as a blow-pipe when fusing a piece of metal. Yesterday morning the doctor was at work upon a piece of gold plate when he noticed the steam leaking from the top of the boiler where the cover is soldered on, and he at once stepped back to get out of the way of possible danger. He had hardly taken one step backward when the boiler exploded with a terrible force, making a sound like a cannon. The doctor was covered with burning alcohol, and his face, hair, and whiskers were somewhat singed. The explosion blew out the entire sash of the two windows in the room, and broke all the glass of those in the next room. Some thirty lights of glass were demolished. A square yard of plastering was knocked from the ceiling, and the heavy partition dividing the laboratory from the office was split and torn from its fastening. The copper top of the boiler, which was about two inches in diameter, was driven three-quarters of an inch into a heavy oak partition. A partition about thirty feet distant, and in another room, was loosened and driven four inches from its former position. The power was generated from a little cup of alcohol holding about two thirds of a pint. Dr. Brown's quick movement upon the apprehension of danger was all that saved him from serious injury.

WHILE Dr. Porter was vulcanizing a set of teeth, the vulcanizer, which was under a strong head of steam, exploded, smashing things considerably, and blowing the window completely out.

RODES' WATER LIFT.

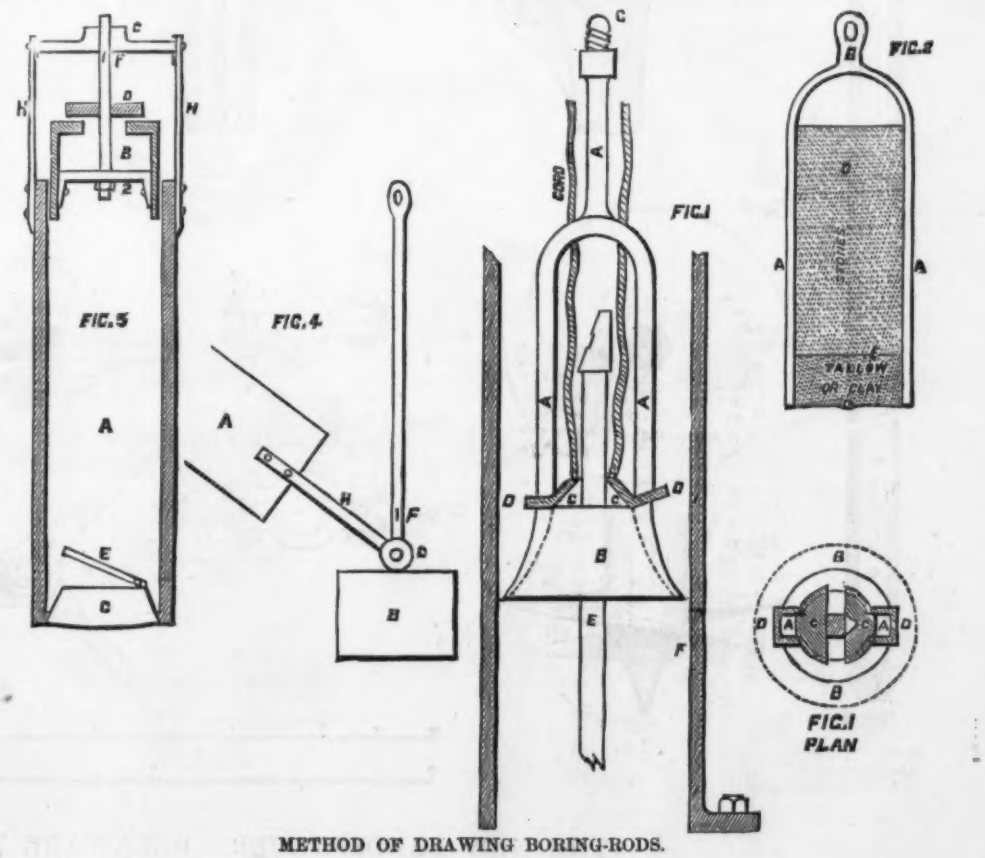
A TRIAL was recently made, with successful results it is said, of an arrangement for raising water, invented by Mr. Tyree Rodes, of Giles County, Tenn. The trial was made on the Louisville & Nashville road and was witnessed by a number of its officers. The arrangement is thus described by the Nashville *American:*

"He uses Heald & Sisco's centrifugal pump—the power applied by wire-rope running gear, from the celebrated Roeblings' wire-rope works, whose proprietors furnished the loan of the gearing without charge. An endless ¾-inch wire cable, several hundred yards in length, works in two large groove fly-wheels—one attached to the shaft which turns the pump machinery, and the other at the other end of the rope, several hundred yards distant along the track. The locomotive stops at the water-tank, and while the water is flowing from it into the tender, the engine-driver attaches to the cable a powerful clamp, which is permanently secured to the locomotive. The locomotive moves off with a little extra speed for a few hundred yards, and its pull upon the rope sets the wheels revolving with great rapidity—the water rises instantly through an eight-inch pipe to the height of fifty feet, and by the time the end of the rope is reached by the locomotive, the pump has replaced in the stationary tank exactly the amount of water that was run out of it into the locomotive tank. As the locomotive approaches the end of the wire rope, the extended clamp from the engine encounters an upright beam placed permanently beside the track at a given distance from the pump, and the contact acts upon the clamp on the principle of a trigger, instantly releasing the clamp and dropping the rope, and that stops the pump until another train comes along, when the process is repeated by the succeeding locomotive, so that each preceding locomotive pumps water into the stationary tank for its successor, without loss of time or expenditure. There is no fuel, nor stationary engine, nor man to attend it required. The engine-driver or the stoker simply attaches the locomotive clamp or grappler to the rope at the time when the water is flowing into the tender, and he has no more care with it. The clamp detaches itself and releases the rope at the required distance, by contact with the upright above mentioned, and the locomotive moves on the even tenor of its way, like a thing of life, with the proud consciousness of having done its duty to its neighbor locomotive as it would be done by.

"For the successful operation of the water lift, it is not imperative that it should be located directly along the track. The rope-gearing is a distance annihilator—that is for any reasonable distance."

DRAWING BORING-RODS.

MR. R. ALLISON says, in the *Engineer:* Fig. 1 is a tool that I have used for very many years with the greatest success, both in bore holes and pumps. A is a forging, say, of 1½ in. square iron, moulded or riveted into a bell-shaped hoop, B. On the top of B are two steel valves, C, attached to A by two square links, D, which enable the valves to open and, also, to slide up and down A. The broken rod, E, is shown after the tool has passed down the pump barrel, F, and, upon the pulling up of the tool, the sharp edges of the valves grip the broken rod, and the more pulling the greater the hold. A cord is applied to each valve to enable the tool to be withdrawn, if necessary. It is to be screwed to rods or to a chain or rope at G. Fig. 2 is a tool for taking an impression or bringing up any small thing that will adhere; A a sheet iron cylinder, B a sling to attach a rope, C tallow or clay, D stones or anything heavy, E a diaphragm. Fig. 3 is a pump that will bring up anything that will enter the lower valve; A, a cast iron cylinder, B a hollow piston, C lower valve box (fixed), D upper valve sliding up the rod, E lower valve, F collar through pump rod to keep piston in place during use, G swing bar through which pump rod passes, H H slings. Fig. 4 shows pump in position for emptying, the cotter F having been knocked out. I may just state that with a pump of 12 in. diameter and 5 ft. long, I have brought up from a bore hole one ton per hour of gravel and sand, and upon breaking a tool in the hole always succeed in bringing it up.



METHOD OF DRAWING BORING-RODS.

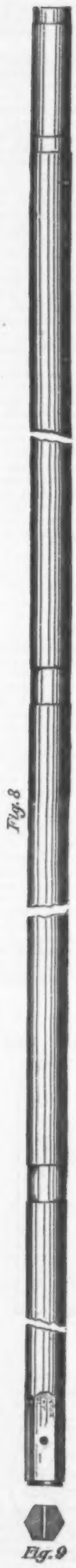


Fig. 8

Fig. 9

Fig. 22

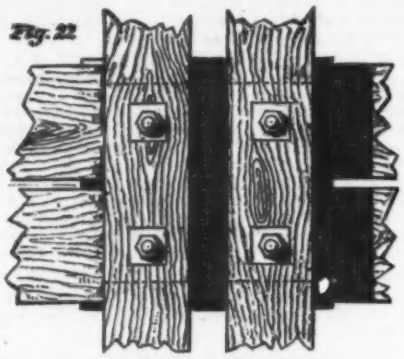


Fig. 30

Fig. 20

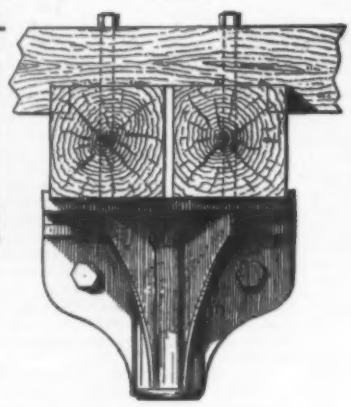


Fig. 21

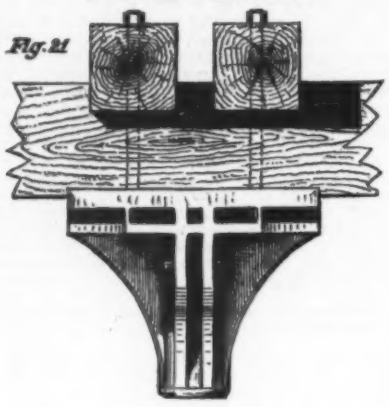


Fig. 23

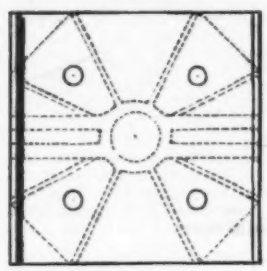
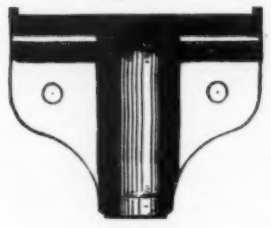


Fig. 24



Figs. 10 & 11

Fig. 27

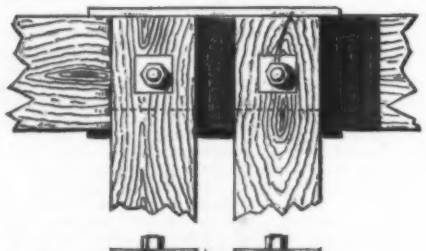


Fig. 28

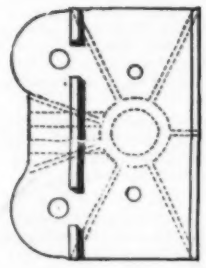


Fig. 31

Fig. 25

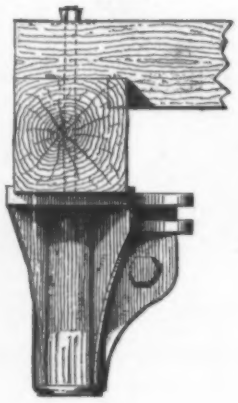


Fig. 26

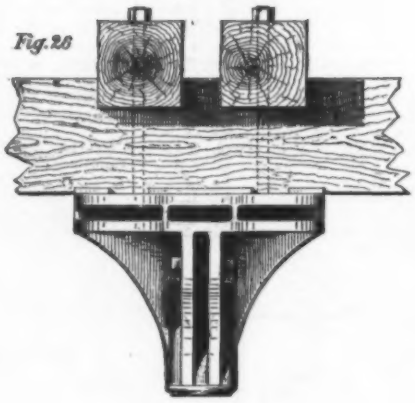
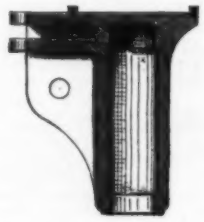


Fig. 29



Figs. 12 & 13

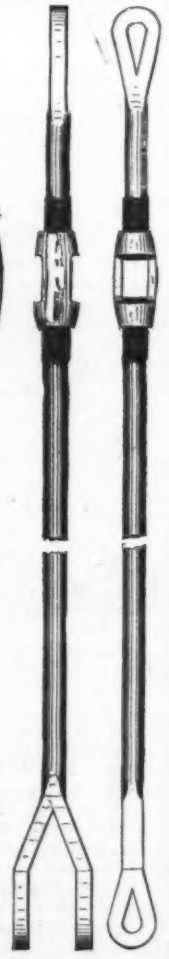


Fig. 14

Fig. 6

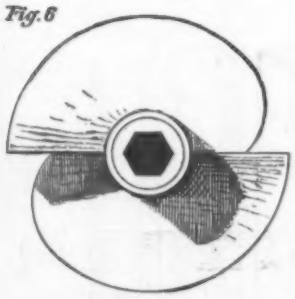


Fig. 7

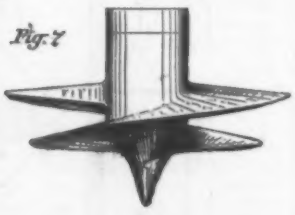


Fig. 15

Fig. 16

Fig. 17

Fig. 18

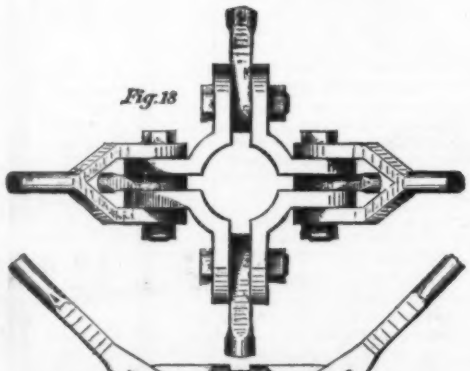
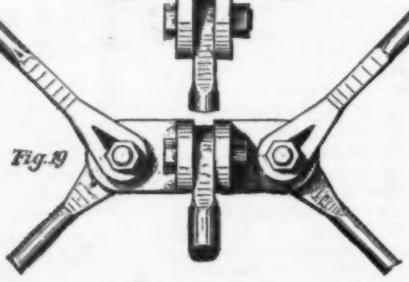


Fig. 19



THE NEW LANDING PIER. DELAWARE BREAKWATER.

THE U. S. IRON LANDING PIER, NEAR LEWES, DELAWARE.

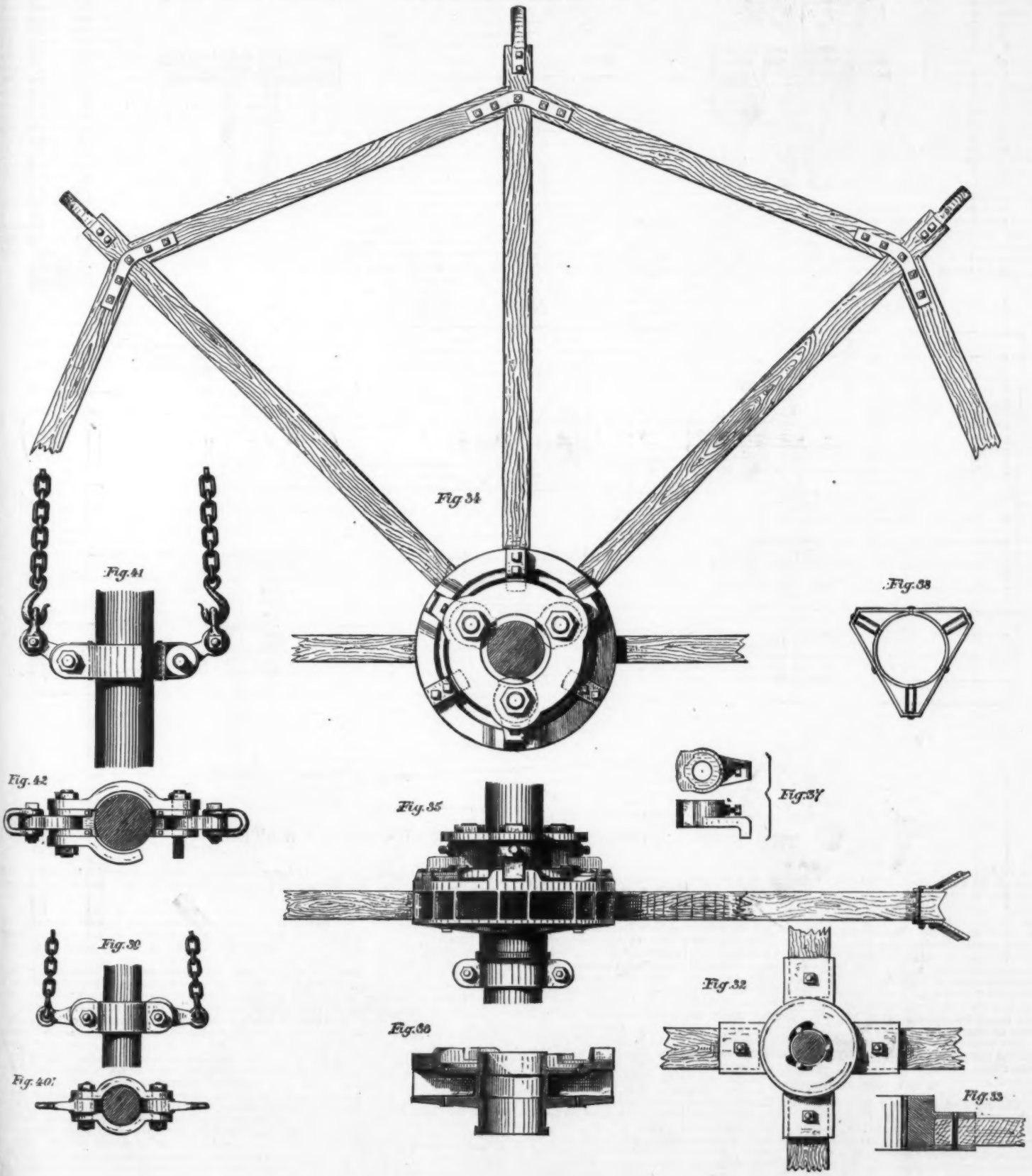
By A. STIERLE, C.E., Assistant Engineer.

(Continued from SUPPLEMENT No. 72.)

In giving now a more detailed description of the different parts of the sub-structure, it will be necessary to mention the foundation-screw first.

1. *The Screw.*—Few were the data which could be obtained regarding the proper shape, the size, the strength, and the thread or pitch of a screw, which would in this case be required to form a safe foundation in a bottom so varying in its character. All the notes which could be collected upon the subject were rather vague, and gave very little practical information; and the only country where these possibly could be more fully procured was England—where Mitchell had invented the foundation-screw and where the latter had already been largely used in the construction of lighthouses, piers, and similar structures. It appeared to be difficult to obtain the full reports upon these works, and it became finally necessary to start anew on the only accessible information in this country, namely, the results on screw-pile foundations in the possession of the United States Lighthouse establishment. Accordingly, from drawings received from the Lighthouse Board, and from new designs made by the officer in charge, several experimental screws were cast, differing only essentially in the pitch of their flanges; their general width and size being about the same. These screws were tested carefully in coarse sand near the shore, and the investigation resulted in the final adoption of a screw, resembling, with slight modifications, one received from the Lighthouse Board. The screw adopted is shown in Figs. 6 and 7, and has double flanges, each making one-half of a turn—their pitch being 10½ inches. The periphery of the flanges approaches that of an archimedean spiral, whose point of development is in the center of the screw near its lower point. The initial part of the flanges is cut off radially for a length of 8 inches, to form a cutting edge; they then rapidly increase to a diameter of 2 feet 6 inches across their upper or widest part; in section they are wedge-shaped, 2½ inches thick at the base, where they join to the hub of the screw, then gradually diminishing to a rounded edge ¼ of an inch thick. A hexagonal socket, 12 inches deep, is cast into the hub to receive the lower hexagonal end of the piles; the latter being fastened therein by a 1-inch wrought iron pin, going through both pile and screw, and slightly rivet-headed on its ends. On account of the tendency to fracture on that part, it was found expedient to strengthen the upper end of the hub with a wrought iron band or ring, 2½ inches wide by ½ of an inch thick, which is shrunk on hot into a corresponding shoulder or offset left there on the casting.

2. *The Piles.*—The upper end or the top of all the piles is for a length of 20 inches turned smooth and true in a lathe—as shown in Fig. 8, which represents one of the 5½ inch piles—to fit into the socket of the cast iron caps which carry the floor-beams. Besides, two other places, called necks, are smoothly turned on the pile, their depth being very slight, not more than $\frac{1}{16}$ of an inch, so as to reduce the diameter of the pile as little as possible; around these, the collars for the braces are tightly clamped. The distance from the top of the pile to the upper neck remains the same for all the piles, bringing the top of the collar fitting therein, when in place, 6 inches below low-water line. The distance to the lower neck is variable—increasing correspondingly with the length of the longitudinal and the lower cross-braces. On the



THE NEW LANDING PIER. DELAWARE BREAKWATER.

lower end, the otherwise circular cross-section of the pile is hammered for a length of 12 inches into that of a hexagon whose greater diameter is the same as that of the pile proper, see Fig. 9. This hexagon fits into the hexagonal socket of the foundation-screw.

All the piles are made in one single piece, of hammered iron, and the largest weigh upon an average *five tons* each; their manufacture, especially in regard to homogeneousness, as successfully carried out by Messrs. Macpherson, Willard & Co., Bordentown, N. J., and partly by Messrs. Paulding, Kemble & Co., Cold Spring, N. Y., being a triumph of mechanical skill.

3. *The Braces.*—The cylindrical wrought iron tension-braces have throughout the same general shape as shown in Figs. 10 and 11. They consist of two pieces—one long one, the lower, and one short one, the upper part—when in place; each piece having on one end an eye formed by a turn and weld with a long scarf, and on the other end the screw-threads which are upset and fulled on the bars and cut with right and left hand threads respectively. Both pieces are connected by a proportionate, barrel-shaped screw-buckle, shown in section in Fig. 14. The lower ends of the upper cross-braces under the pier-heads were forked, and are fastened to the outside of the lugs of the collars whose bolts are correspondingly lengthened to go through the upper end of the lower cross-brace, the collar, and the forked end of the upper cross-brace, as shown in Figs. 12 and 13.

4. *The Collars.*—The wrought iron collars, to which the braces are fastened by corresponding bolts and nuts, are made in two pieces for the cross-bracing of the bridge-part of the pier, as shown in Fig. 15, which represents a collar of the outer row, and in Fig. 17, which is one of the collars of the inner row of piles. Under the pier-head, where they form the place of attachment for the longitudinal braces as well as for the cross-braces, they consist of four pieces, as shown in Figs. 18 and 19—those on the inner rows of piles receiving respectively four eyes of braces, and those along the outer rows only three. The holes for the bolts and the inner surface of all collars are worked smooth and true to insure a close fit.

5. *The Caps.*—All the cast iron caps have centrally a hub with a socket 20 inches deep and finished smoothly inside to fit over the turned and slightly reduced head of the piles. The diameter of this socket increases with that of the piles, all other parts of the caps remaining the same throughout. The top of the cap forms a wide bed-plate, which, in the case of the inner rows of piles—carrying, as they do, two stringers of the floor (see Figs. 20, 21, 22, 23, and 24)—is 26 inches square, and in the rows of the outer piles, carrying one stringer only, 26 by 13 inches wide, as shown in Figs. 25, 26, 27, 28, and 29. The superincumbent weight of the floor is transmitted directly to the hub or socket of the cap—and by it to the pile—by vertical lugs which receives the upper eye of the cross-braces, and by vertical ribs or flanges radiating from the center of the socket. Under the bed-plates all caps are provided with horizontal lugs for tension-braces, which are at present omitted, in case it should be found requisite in the future to add a series of horizontal bracing under the floor to insure a greater rigidity.

The reference of the top of each cap, after being placed on the pile in position, is exactly 11 feet above mean low-water line.

6. THE SUPERSTRUCTURE.

The floor of the pier is built of the best Florida yellow pine. Over the bed-plates of the cast iron caps, and parallel with the axis of the pier, are laid continuous string-pieces, 12 by 12 inches thick. They are scarfed together every alternate pile, and, as already mentioned above, the middle or inner rows of piles have two such girders, laid 1 inch apart, and the outer rows only one, as shown in Figs. 3, 4, and 5. These stringers are connected crosswise, and directly over the caps, by two cross-beams 9 inches square, notched 2 inches on, and 3 inches down into the stringers, and laid 4 inches apart. Long bolts with broad wrought iron washers and nuts—Figs. 30 and 31—and passing through the cross-beams, the stringers, and the caps, fasten these main members of the floor securely to the substructure. These bolts have an increased diameter where they pass through the horizontal lugs of the *inner* caps, as shown in Fig. 30, serving as points of attachment for the horizontal bracing, if necessary.

Into the bays thus formed, and parallel and between each set of cross beams, 13 floor-joists, 4x9 inches thick, are laid and notched in the same manner, as the former, into the stringers, without any other fastening, their upper or smaller side thereby assuming the same general level. Over these joists and the cross-beams, and on one side of the pier only, 8 by 12 inch, R R stringers are laid—for a single track on the narrow, and for a double track on the wider, part of the pier. On the other side, another set of smaller joists, 4 inches square, cross the lower joists lengthwise with the pier, to which then again a cross-planking of planks 3 by 6 inches thick, and lying 1 inch apart, is spiked, being the part of the pier reserved for common wagon traffic. The space between the R R stringers is also covered with the same size planks, but running parallel to them. Finally, to give a better finish as well as for protection, a guarding-strip, 4 by 9 inches thick, is spiked along the outer edge of the floor over the ends of the planking on both sides

An abutment, about 25 feet wide, with a short wing on each side, and built of granite, with brown stone facing (stones lost by vessels wrecked near the harbor), forms the initial part of the pier near high-water mark on shore. The shore ends of the stringers of the floor rest in corresponding shallow recesses, cut into the coping; the connection with the higher ground in the rear being made by a temporary plank-walk, which will eventually be replaced by a gravel or sand enbankment.

THE CONSTRUCTION OF THE PIER, AND THE PLANTS, AUXILIARIES, ETC., NECESSARY THERETO.

In commencing the construction of a work of this kind, a work so novel in its character, so little assisted toward a successful completion by empirical rules and data derived from other works of similar kind, and which, therefore, during its first progressive stages only, at the moment when the difficulties really presented themselves, could develop and lead to the requisite contrivances necessary during the operation, became obvious that, at first, the working method as well as the plants could to some degree be only experimental or could only form a basis upon which future improvements should advance. All appliances, tending toward a satisfactory construction of the substructure, especially toward the insertion of the piles, were therefore necessarily crude in their conception; but subsequently subjected to continual improvements, skilfully contrived, they finally attained such a high standard of working order that the results were entirely beyond all former expectations, and certainly exceed, as far as rapidity, ease, and correctness of execution is concerned, those ever obtained in other kindred works.

One of the first questions which presented itself was the designing of a suitable apparatus by which the pile-shafts could be at once easily and expeditiously inserted.

The methods employed in the construction of the screw-pile piers at Courtown-Wexford, in England; at Glenely, in South Australia; and at Makassar, Island of Celebes, East India, could not well be discerned from the meagre reports afloat. To follow the manner of inserting piles applied in the construction of lighthouses, by either having a seat or groove planed nearly the full length of and into the pile for a corresponding key in the collar forming the turning-wheel, or by inserting two strong set-screws fixed in an iron ring into the head of the pile, from which ring two chains were suspended carrying a capstan-head with levers which, when set in motion, wound the chain several turns around the pile, until finally, by sheer entanglement, the latter was turned also, was not thought advisable. The objections to either method were, besides the loss of time in adjusting the different parts each time, the unavoidable cutting and scarring of the smooth and hard surface of the pile, causing spots easy of access to corrosion.

After many fruitless attempts to devise something which would answer this purpose better, a very ingenious collar was designed which solved this problem in a very simple manner. A very large wheel, whose diameter was subsequently reduced considerably, for reasons which will be mentioned hereafter, had for its central part a cast iron collar made of McAffey metal, and shown in Figs. 33 and 33, whose open center was about 6 inches in diameter. Around the periphery of this open central core were cast in the body of the collar three wedge-shaped recesses, equidistant apart, their axis running nearly concentric to the former. Into each of these recesses, which were vertically not as deep as the collar was thick, a cast steel pin, 1 inch in diameter and 6 inches long, was dropped upright after the collar was slipped over the pile to be inserted. A small wrought iron clamp, made in two halves, each half provided on its inner surface with numerous small and slightly projecting steel points, was then clamped around the pile and directly under the wheel, for the purpose of holding the latter up. If the collar was now turned, the steel pins in the recesses would soon, after once coming into contact with the pile, receive a tendency to roll into the narrower part of the recess, pressing more and more against the pile until they would finally carry it around. It will be seen that, the greater the resistance which it was necessary to overcome, the more securely would the pins retain their hold upon the softer iron—the pile.

For this collar, which was very simple in its appointments, however, another collar was substituted when the larger piles were reached, and which also worked admirably, and upon the same principle, but was considerably more elaborate and expensive. It is shown in Figs. 34, 35, and 36, and consists of a main part of iron (Fig. 36), having eight sockets for the arms of the wheel; the center being open and 9 inches in diameter, to allow it to be slipped easily over the 8½-inch piles. To the upper face of this larger part are held loosely, by three flat pieces of angle iron, two annular wrought iron plates, each 1¼ inch thick, and resting directly upon a triangular carriage-frame provided with three small rollers, as shown in Fig. 38, between which are placed three short eccentric levers of a peculiar shape. These levers are shown in detail in Fig. 37, and are 4 inches high, turn around bolts 2¾ inches in diameter—the bolts going through both plates—and form on one end, that near the center of the collar, a strong head of cast iron, with a broad checkered face of an eccentric curvature, which is fastened to the main part of the wrought iron levers by a set-screw; and on the other, the outer end, a longer arm whose point is bent down at right angle to fit loosely into a corresponding recess cast upon the upper surface of the main collar.

All that was necessary in inserting a pile was to retard the progress of the wrought iron plates slightly whilst the wheel is set in motion; the eccentric levers would thereby become jammed against the pile and turn it round.

Fig. 43

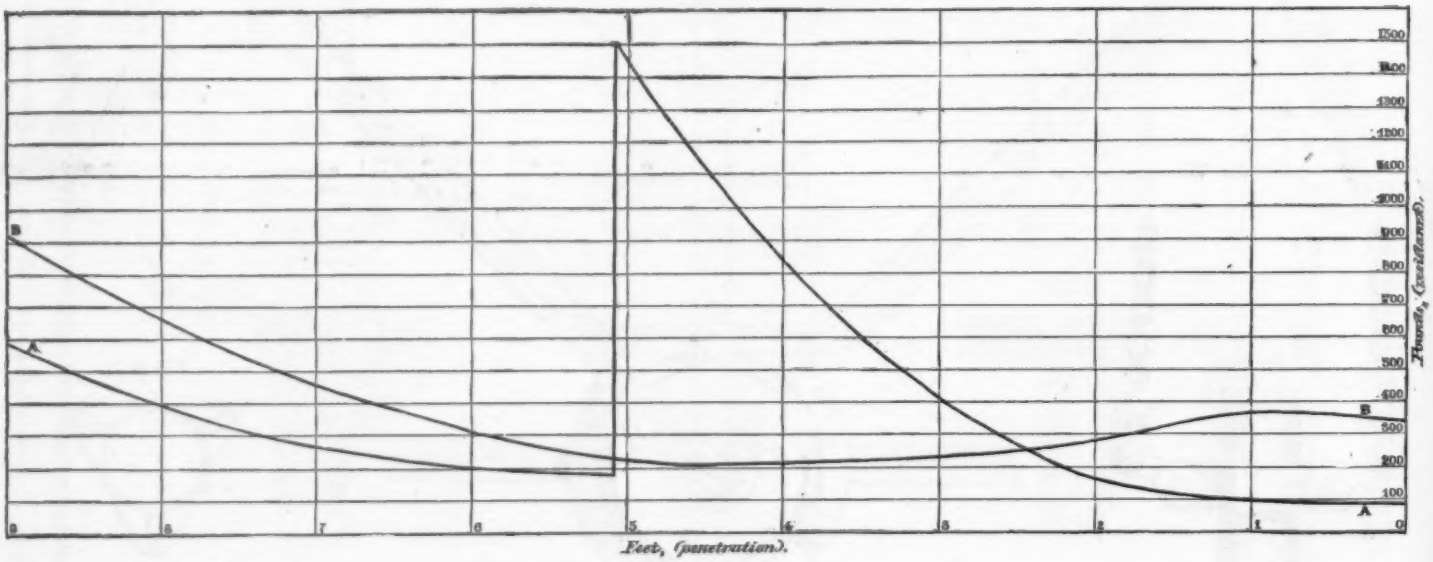
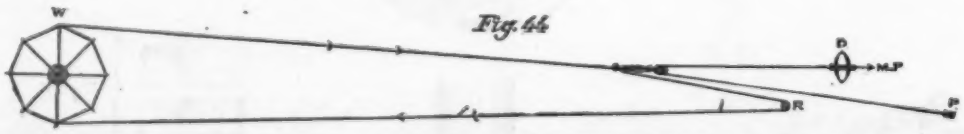


Fig. 44



THE NEW LANDING PIER. DELAWARE BREAKWATER.

At first, the small iron clamp upon which the collar—in fact, the wheel—had to rest, was still used; later, this arrangement was replaced by an automatically working clamp of two knee-jointed levers which, when the weight of the wheel came to press upon them, bore against the pile below, holding the whole of the turning apparatus, at a moment's notice, within any height or at any place of the pile required.

Another difficulty which presented itself during the first stages of the work was the successful insertion of the piles to the designated depth of 10 feet; to reach this depth seemed to be almost impossible in the coarse gravel bottom of the shore. During the tests made with divers experimental screws at the time when the adoption of a proper foundation-screw for the pier was still pending, several of them had broken before they had penetrated to a depth of 10 feet; the only screw withstanding these severe trials having been the one upon which the adopted screw was modelled, and which then had been inserted to a greater depth than was requisite. Notwithstanding this strength of the new model had been apparently established when the first and second row of piles were inserted, two screws had again broken before they had penetrated a depth of 8 feet into the sand. The flanges in each case were nearly completely stripped off the hub of the screw. There is no doubt that the fracture, partly hastened by holes which had been drilled through the flanges for a certain purpose, had in reality been caused by the excessive friction upon the flanges, wedged, as they were, between the almost solid bottom below and the heavy cone of sand above, whose weight increased nearly in the same proportion as the depth increased. It is also certain that those parts of the flanges having the larger radius broke off first; their outer edge being thin and moving with greater velocity, it was there where the friction must have caused rupture first, as

was fully shown when the larger top-pieces were dug out and found nearer the surface of the ground than the other smaller pieces.

These early accidents clearly demonstrated that the diameter of the screws was too large for this soil; it was, therefore, thought best to reduce the flanges 6 inches, until some means could be found which would prevent their future breaking and which would especially insure a more rapid and easier penetration—trials to which effect were then pending. Nearly all of the remaining piles of the first and second row were meanwhile inserted like the two piles whose screws had broken, by digging away the sand to a depth of about 5 feet and then screwing them down the required depth. This was comparatively easy work, as the position of these piles is above low-water mark; but at the third row of piles, which is the first one standing in the water, this rather extempore process was no longer feasible.

Previous to the beginning of the work, an idea had been entertained that it would be possible, or that it would at least materially help to a successful insertion of the piles, if a jet of water could be forced under the screw during its rotation. This idea was suggested by the sinking of tubular bridge-piers and hollow piles, successfully accomplished elsewhere with the aid of a pneumatic apparatus. But all attempts made in that direction failed; the solidity of the piles and screws not permitting the method spoken of in this case. The two flanges of the screw had been perforated with large holes, through which gas-pipes, 1¼ inch in diameter, were passed; the upper end of the pipe reaching well above the ground where they met in a common, U-shaped joint, provided with a nozzle to which a 2-inch rubber hose was attached; the lower end extending to the point of the screw below. The hose having been connected with a small force-pump, worked by hand, a stream of water was forced down the pipes directly *under* the screw during the insertion of one of the first piles, but resulting in no advantage whatever. In examining the recovered pieces of the broken screw mentioned above, it was discovered that the upper surface of the flanges seemed to be more affected by the immense friction than any other; in fact, had the appearance of having received a high polish. It was then proposed, during the insertion of the next pile, to throw the jets of water directly on *the top* surface of the screw-flanges—rightly anticipating that the friction would thereby be reduced—and the results obtained were favorable in the highest degree.

The great and many advantages derived from this new discovery cannot be better illustrated than by the accompanying Fig. 43, which represents two ideal curves, selected and reduced from original curves obtained by the aid of a spring-dynamometer during the insertion of different piles. This dynamometer was constructed upon the same plan as the one used by General Aborin in his researches on friction, and described fully in his *Description des appareil chromométriques à style et des appareil dynamométriques, Metz*, 1838. It consisted of a powerful O-shaped carriage-spring, each half having seven blades. From one half of the spring hung, suspended on a small iron frame, a box, containing a clockwork driving two rollers over which a long paper strip, 6 inches wide, passed; and to the other half was fastened a pencil, resting lightly with its point upon the paper strip below. There was further fastened to each half of the spring, and then crossing and extending over the opposite half, a strong wrought iron link, provided on its end with a strong ring, to one of which the rope transmitting the motive power was attached, and to the other, by means of a bight in the rope itself, the endless rope wound around the wheel on the pile, as shown in the diagram, Fig. 44, where D indicates the dynamometer; M–P, the motive power; P, a fixed post; W, the wheel; and R, a fixed roller or block. This very sensitive mechanism, interposed, as it was, between the power on one side and the resistance on the other, was an exact measurer of these forces, from the first moment to the last, by tracing the resultant—a curve—automatically upon the paper strip; but it was in the determining the reduction of friction upon the screw-flanges by the water jet, that its reliability was best shown.

Curve A–A is one obtained during the insertion of a 5½-inch pile, 798 feet from the abutment. It will be observed that at a depth of 5 feet and 1 inch it attains its highest point; in other words, the motive power, which in this case was the united power of 4 mules, could no longer overcome the excessive friction or resistance on the pile. At that moment, the force-pump was started and made to throw the jets of water upon the screw-flanges—which could be easily done by the pipes, working their way down, being held by a man who directed them—and the reduction in the friction was immediately shown by the curve falling from 1,515 pounds resistance to only 180 pounds, a reduction of about 89 per cent. The curve then rises again toward its end, showing that the pump lost its power in the same proportion as the weight of the superimposed cone of sand increased the friction upon the screw-flanges; and further showing that the pump, had it been necessary to insert the pile to that depth, would have been useless finally, after a penetration of the sand of about 11 feet. Yet, although it was not required in this case to reach this depth, it is obvious that with a more powerful pump the friction might have been greatly diminished, if not entirely neutralized, and that the insertion of solid piles to a greater depth than was heretofore thought possible, is undoubtedly practicable.

The strain being less, all the materials, planks, etc., used directly in the insertion of piles may be considerably reduced in size, strength, and in their cost; and of especial gain will be the saving of time in handling lighter machinery. As an instance, may be mentioned the wheel, which until then had levers or arms 32 feet long, but was now reduced to 15 feet in diameter, having arms only 7 feet 6 inches long.

Curve B–B, Fig. 43, is one obtained from a 6½-inch pile of the last row of short piles, 1,197 feet from the abutment. It is interesting in as much as no water-jet was used during the insertion of this pile, and as it shows the already soft nature of the bottom at that distance, as indicated by the rising of the curve in its commencement, when the penetration of the harder top stratum took place (see Fig. 2); and by the falling of the curve when penetrating through the softer underlying strata mixed with mud.

Without going into any further detail of these valuable researches made with the dynamometer, it may be added here that, as the latter was fixed to a rope passing through a movable block, the strain upon the main rope passing around the wheel of 7 feet 6 inches radius, was, of course, double that indicated on the curves; further, that if a curve is constructed whose abscissæ represent the depth of a cone of sand, and whose ordinates represent the weight of the same for each depth respectively, it will be identical with the curves described above; if, in the delineation of the latter curves, any possible local obstructions in the machinery are not taken into consideration, and the limiting angle of resistance and the weight per unit of the sand—which will, of course, be different in hard or soft sand—have been previously determined. The co-efficient of friction for cast iron moving through coarse wet sand was found to vary between 0·76 and 0·84.

It remains now to describe the mode of operations followed, after the same had acquired more of a routine character and were no longer encumbered by difficulties and experiments as during the first stages of the work. As the method pursued in the building of the pier-head, where the largest piles are placed, must necessarily have differed somewhat from the one followed in shore, the latter will be described first.

All piles were stored on a raised platform built near high-water mark on shore. When needed for insertion they were rolled and loaded on two pontoons, 6 feet wide and 30 feet long, both fastened alongside each other by timber pieces extending entirely across, and floated to the place required. Sometimes three or more were taken out together, depending upon the work in view. After the pontoons were anchored across the head of the built portion of the pier, the pile was raised and swung free by a single-boon derrick with the aid of an eccentric clamp, shown in Figs. 39 and 40. The derrick stood on a movable platform resting upon temporary stringers laid longitudinally across the caps of the last-inserted piles. Directly fastened to the last pile, standing in the same longitudinal row into which the pile was to be inserted, was a contrivance called a guide, which was simply a strong parallelogram-shaped frame, 10 feet high, having on its four corners round wrought iron clamps, the distance between whose centers was exactly 21 feet, measured horizontally, to conform to the width of one bay. The two rear clamps of this guide were tightly clasped around a pile of the last row inserted; and into the two front clamps, which were slightly larger in diameter, were swung the pile, still suspended from the derrick. With a transit, and from an instrument-station near the abutment on shore, having, a half-mile in the rear, corresponding back-sights for every longitudinal row of piles, the pile was then accurately sighted into line, and, after the guide was well braced from its forward end by long timber pieces running diagonally back to piles already set, slowly lowered to the bottom. The wheel was now raised and lifted over the pile; the endless rope wound several times around it and carried to the already finished part of the pier, several hundred feet in the rear, where the mules—the motive power which for certain reasons it was thought best to employ—were hooked on to a bight in the same; and, finally, after correcting any possible derangement of its position, the pile was set in motion. As soon as the mule power could not turn the wheel any longer, which generally took place after a penetration of between 5 and 6 feet, the force-pump throwing the water-jet was applied until the pile was fully inserted. The last turns of the wheel and pile were carefully guarded with a leveling instrument, referring all piles to the same bench-mark fixed into the stone abutment.

After each cross-row of piles was thus inserted, the caps were placed over them, the temporary stringers laid, and the derrick moved ahead. The cross-bracing of the last rows inserted, and the laying and finishing of the superstructure followed close upon the foot of these manipulations, and were accomplished at the same rate of time as the latter progressed.

When the long piles were reached, this hitherto-followed programme of construction was slightly changed. The derrick had been replaced by a stronger, heavier one; a somewhat modified self-tightening clamp for slinging these heavy piles was used, and is shown in Figs. 41 and 42; for the two pontoons was a single one, 35 feet long by 17 feet wide, substituted, and of such a capacity that five of the piles (54 feet 6 inches long and 8½ in diameter) could be floated to the end of the built portion of the pier; further, as the piles penetrated with comparative ease the top strata of the bottom, which were soft, and the short distance into the gravel-bed upon which they rested, the water-jet was no longer used. It also became necessary now that the longitudinal and the cross-bracing of the last row of piles inserted should be finished before the heavy derrick could be moved forward. The fixing of the braces under water was accomplished by a diver, and depended greatly, like all other work in the construction of such a structure, upon the state of the weather and water.

Notwithstanding the comparatively exposed position of the pier, the results obtained in its construction, especially as far as rapidity is concerned, have been exceptionally good, and certainly have never been exceeded in the construction of similar works before: five of the smaller piles were often inserted in eight hours—a Government working-day—and six of the larger piles in five days. The best progress once made under favorable circumstances, however, was during 25 days of almost continuous good weather, when 14 large piles were inserted, and two bays completely braced.

The working force consists of 3 carpenters, 1 overseer, 1 diver, 10 laborers, 1 teamster, 1 painter, and 1 boy.

The auxiliary buildings are: storehouse with office-rooms, carpenter shop, blacksmith shop, stable, boathouse, small scalehouse, and the barracks for the laborers.

It has been observed since the erection of the pier that the general effect of the same upon the bottom in its vicinity has been that of deepening it; and that, whereas the surface of the piles and of the other iron below low-water line seems, as yet, to be perfectly smooth and intact by corrosion, the portion of the piles between high and low water line shows already conspicuously the combined action of the salt water and the sea air upon the iron, by raising small, blister-like scales upon its surface. It is at this place, consequently, where the strength of the pile will be first attacked by the reaction of a combination of chemical forces, to prevent which no agent has yet been discovered.

SELF-TRIMMING SCREW COLLIER.*

By Mr. W. DENTON.

THE object of this paper is to describe an innovation in shipbuilding, which is now becoming so general in its application to the screw collier as to merit the attention of all who are interested in the architecture of our mercantile fleet. From time immemorial the shipment of coal cargoes has been attended with the trimming or stowing process, performed by a class of men known as "trimmers." During the loading of the vessel these men go into the holds, and shovel the cargo into the spaces beyond the hatchways, and stow it in such a manner that the movements of the vessel at sea will not disturb it.

About three years ago, a north-country coal company conceived the idea that the labor of trimming could be considerably reduced, and that the arrangements of the vessel could be so altered as to accomplish this. In Fig. 1 I have illustrated the scheme which was adopted to attain this desirable end, and have applied the arrangements to a vessel of moderate dimensions. She is divided into five water-tight compartments, and has two holds for the cargo. To fill these holes so as to dispense with trimming, two large hatchways are used, and the cargo, poured in from the loading spout, distributes itself by its own gravitation. When the loading of the vessel is completed, the coal is simply levelled in the hatchways by the men who had hitherto to work below the decks. The position of the cargo when the vessel is ready for sea is shown in the diagram. It will be observed that there are large empty spaces in the "wings," but to prevent the cargo occupying them as the vessel rolls, a substantial wooden barrier is fitted. The width of the hatch opening at the deck line defines the height to which the coal will run, and from that point to the vessel's side the surface of cargo forms an angle of 32° to 38°, according to its quality and condition. This scheme is exceedingly simple, but bears little traces of having had much professional thought or skill bestowed upon it. The primary end had been attained, the saving in labor effected; but it was only by making excessively large holes in the decks, the disadvantages of which will be apparent to everyone here. The actual opening to the sea is equal to 30 per cent. of the total deck area.

FIG. 1.

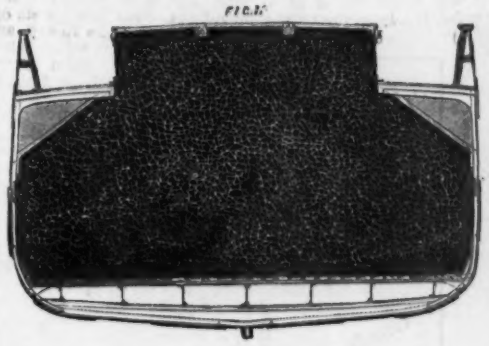
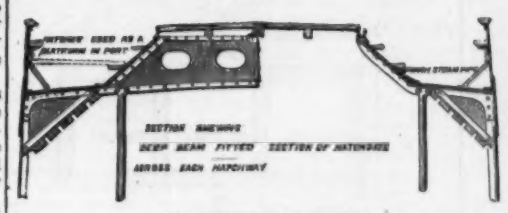


FIG. 2



SELF-TRIMMING COLLIER.

Simultaneously with this attempt to secure self-trimming—viz., in January, 1874—another method was matured by Mr. John Price, late chief surveyor to the Liverpool Registry for Iron Vessels, who designed a hatchway—Fig. 2—which it was contemplated would modify the objections to exposing excessively large surfaces of loose hatchways to the violence of the sea, and, together with a series of iron shoots, permit the inflow of the cargo into spaces it could not otherwise penetrate, unless manual labor was resorted to. The coamings are sloaped, so that the coal in entering the hold will not be impeded—i.e., the angle is more acute than the angle of repose of the coal—but it will be seen that, whilst offering a maximum opening at the point which defines the height of inflow of the cargo, it secures what was previously lost sight of—a minimum opening to the sea where there is only temporary protection, and where danger constantly threatens the safety of the vessel. This opening amounts to 15 per cent. of the total deck area, as opposed to 30 per cent. in the first style of self-trimmer described.

The construction of these hatchways and decks may be thus briefly described: The decks are of iron, all fore and aft; angle iron beams are fitted on every frame, and in the hatchways are bent to the slope of the hatch side, and so preserve intact, as nearly as possible, the continuity of the deck. Between the hatchway, the beams and iron decks are, of course, continued right across the vessel. The vertical part of the coaming is a new section of iron specially designed and manufactured for the Price hatchway. Platform steps are fitted along the hatch side, and form a ladderway from the deck to the top of the hatchway. In ports where the cargo is discharged by the jumping process, the temporary erection known as "Paddy's Ways" is not required, as the sloped hatch side, with the two fore-and-aft steps, answer the same purpose. It will be seen that this form of hatch side offers a much greater lateral support to the vessel than if the coamings were fitted vertically, and—what is of still greater importance—the actual opening is reduced to a reasonable area.

* Institution of Naval Architects.—Abstract.

IRON TIES FOR RAILROADS.—Iron ties are being tried on a section of the Central Pacific Railway, and are said to prove very satisfactory. They consist of circular concave plates, sixteen inches in diameter, with a saddle upon the top in which the rail is set, much as in the ordinary chair. The outer half of the saddle is cast with a plate or bed-piece, and the inner half is secured with bolts after the rail is in place. An iron cross bar connects the plates on opposite sides, the bar having a joint in the center held by a bolt, with an elastic material in the joint. Elastic material is also placed between the rails and the bed-plates. It is claimed that the plates give a better support than wooden ties, and are much more enduring, and that so, although costing twice as much as wood ties, they are more economical. The interest account will probably after all settle the question between iron and wood as a material for ties. The mechanical difficulties in the way of a good tie made from iron are small, since, by the use of a cushioning material, the advantages of wood may be gained where iron is used.

THE arms and ammunition factories in Connecticut, including the Bridgeport metallic cartridge factory and the Brown Brothers' factory at Waterbury, are running night and day to fill orders from both Russia and Turkey.

THE GREAT COMSTOCK LODE.

By ALBERT P. SCHACK, E.M.

THE sister cities—Virginia City and Gold Hill, which form the "mining camp" of the Comstock—the greatest silver and gold-producing district in the world, are situated in Storey County, the southwestern part of the State of Nevada. The practicable ways of reaching the Comstock are as follows: From San Francisco, by the Central Pacific Railroad; northeastward to Reno, thence by the Virginia and Truckee Railroad, southward to Gold Hill and Virginia City; from New York and the East the route is by the Union Pacific Railroad.

The "Washoe range" of mountains—the most prominent peak of which is Mt. Davidson—is an offshoot or spur of the Sierra Nevadas, which separate upper Nevada from California. This range occupies about two-thirds of Storey County, and runs from Carson City, the capital of Nevada, northward, passing Gold Hill and Virginia City on their west side, and extending to the Truckee River, the northern boundary of the county. Hills, valleys, and canyons are alike barren and destitute of natural growth, with the exception of the inevitable sage-brush.

The Comstock Lode or vein, like other "true-fissure" veins, is a long, deep and comparatively thin mass of metaliferous quartz and other kindred matter, filling a fissure made in the solid rock by igneous action from below, the fissure and its vein being at a considerable inclination or slant from the horizontal.

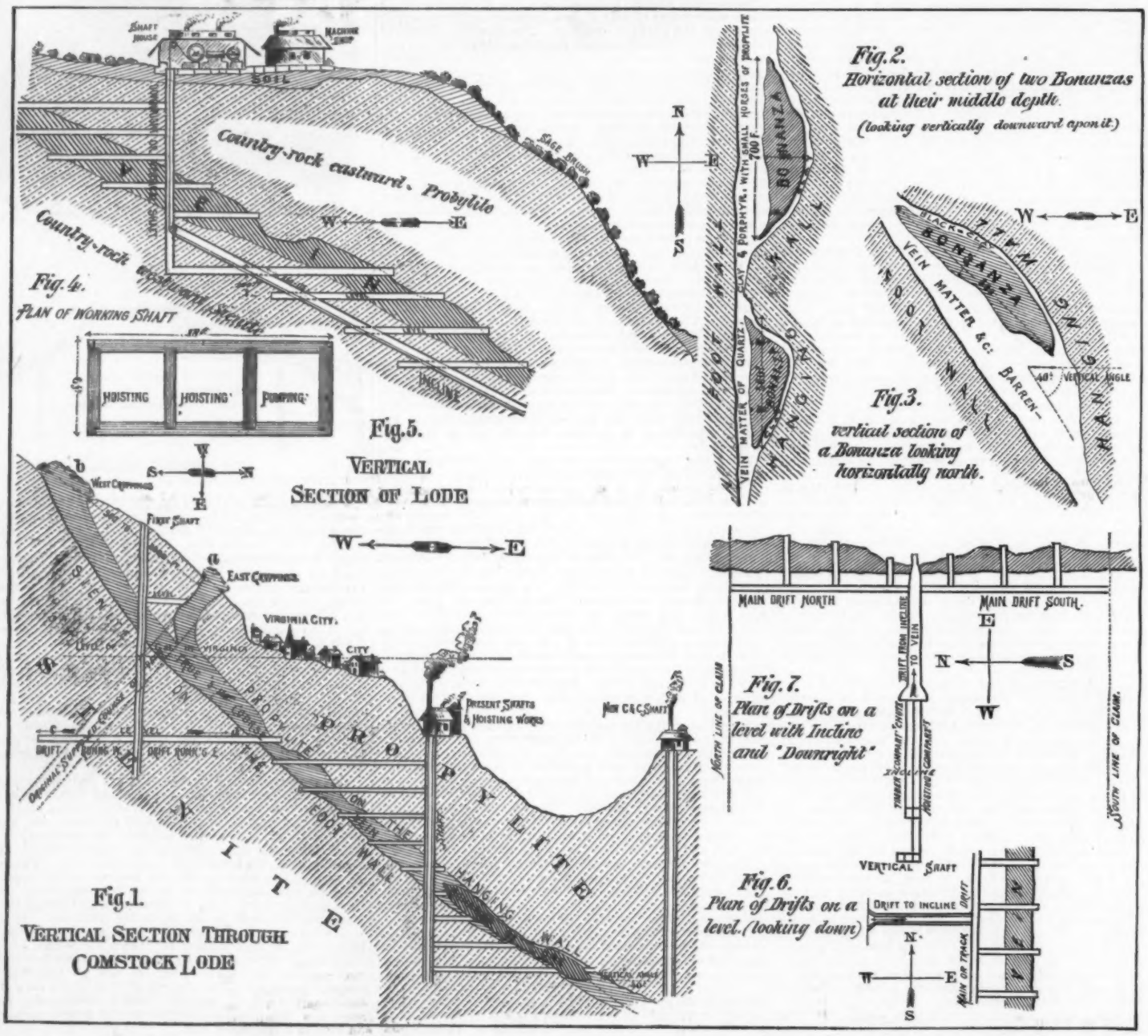
Veins of quartz are usually found at or near the base of mountains, and sloping nearly at the angle of the face of the mountains. They also tend to curve around in their length or course, following the curves of the mountains. The Comstock fissure and lode form no exception to the rule.

The original developments, as those of the Ophir, Gould & Curry; Savage, Hale & Norcross; Chollar Potosé; Imperial, down to the Belcher and Overman, embrace that part of the Lode which runs along the eastern slope of Mt. Davidson for a distance of about two miles. This distance has been greatly extended, however, by the comparatively new claims, such as Justice, Silver Hill, etc., south of Overman; and Sierra Nevada, Utah, and others, north of Ophir. Let it be understood that all these mines or claims are not side by side or scattered about the country, but that they are merely various lengths of, say 100 to 1,000 feet along the same line of Lode, so that the north line of one claim is the south line of the next, and so on. Although the Congressional law of 1872, in regard to mining claims, limits claims from the date of its action to 1,500 feet on the length of a lode or vein by 600 feet in width across its outcroppings. The original claims along the Comstock are generally understood to be indefinite in their extension eastward, or perpendicular to the course of the vein, so far as they do not interfere with other claims on parallel ledges or lodes. The case is different with the more recent claims which come under the above law.

In order to see why fissures and their veins tend to occur at or near the bases of mountains, or between the mass of the mountain itself and its overlying stratum, it is necessary to understand that the mountains were *in situ* before the internal volcanic action or earthquake caused the fissure or rent. The fissure would naturally take the line of least resistance, wherever that might be. The mountain when it was thrown up would have already tilted the horizontal strata up to an angle with the horizontal, equal to that of its own surface slope. The dividing-line or boundary between the mountain itself as it extends downward, and the overlying strata which it has forced or tilted up, would naturally be the line of such least resistance to any internal pressure; on account, not only of their being distinct, but also on account of the great weight and solidity of the mountain mass. When the fissure was formed, there was in all probability a simultaneous ejection from below of a great quantity of semi-liquid and quartzose matter into said fissure. This, in ascending, broke large masses of the country rock from the "hanging" or upper wall, and also from the "foot" or lower wall, more especially from try rock, which either reduces the quartz and quartzose matter to a very narrow width, or else cuts it off entirely.

Mt. Davidson and Mt. Butler, the adjacent peak, consist of *sienite* which is a mechanical mixture of quartz, feldspar—both whitish and hornblende—a blackish mineral, presenting a coarse pepper-and-salt appearance, making a very hard rock similar to granite. This rock, therefore, constitutes the western or "foot" wall of the vein on the eastern slope of these mountains, although the west wall in the southern part of Gold Hill consists of other rocks called "metamorphic rocks," owing to the fact that they have been changed from their original character and position by the action of heat, moisture, etc., while north of these mountains a rock called "propylite"—so named by Baron Richtofen—and which is a kind of porphyritic feldspar of almost all colors—light green, blue, red, and black, resemblimg clay or argillaceous slate—forms the west wall. This last kind of rock—propylite—constitutes the east or hanging-wall, continuously from one end of the vein to the other so far as worked.

Each of the inclosing walls of sienite and propylite, is separated from the vein matter by a thin sheet of black clay called "selvage," and in the mine, if a drift or tunnel is run perpendicular to the course of the vein to reach it, the appearance of this clay indicates the immediate proximity of the vein, and when it reaches another clay selvage in going through the vein, it is known that the latter has been tra-



the former, which masses must have fallen into the vein and form the small and large "horses" which we so often hear spoken of in mining affairs. The quartzose matter would find its way to the top of the fissure as a rule, and there form the "outcrop" or "croppings," which, in some parts of the course of the Lode, are more or less prominent, and in others not observable. But when the convulsion by which it was thrown up ceased, the quartzose matter being in a semi-liquid mobile state, as before said, would fall down again as it ascended, if in its passage it did not break the surrounding walls, and thus form an impenetrable obstruction somewhere in its course to its own downward and backward fall. This obstruction would end the "bonanza" or chimney of ore. Below it the wall-rock would break in, and close up the fissure as just observed, until perhaps the descending quartz below had crushed in some more wall-rock, and formed another bottom for this lower "bonanza" of mineralized quartz. And so there might even be a third so-called "bonanza" some distance below that. Or these bonanzas might all have been formed at different times corresponding to various upheavals and earthquakes, when the same process would obtain, as in the case of the first and highest body of ore. These views would account for the fact that, as a rule, a second bonanza of rich ore is not "struck" in continuity downward with a former one, but only after passing through sometimes several hundred feet of the country-rock.

The "strike" or course of the vein is nearly magnetic north and south, that is, 16½° east of true north, this being the magnetic variation. Its dip is directed eastward, and varies in the different claims from 84° to 45° downward from the horizontal. In rising, however, the vein at the top has been penetrated in the middle by a vast "horse" of about 650 feet wide, and this has tipped up the eastern half of the vein for a depth of 400 feet, so that it dips westward as in Fig. 1, which represents a vertical section of the vein, showing its two branches at the top. It is more than probable that the vein matter pressed so hard, in its ascent upon the hanging wall, that, when it reached a point where the weight of the overlying mass was comparatively light, it made another fissure or method of exit for itself, besides the first, and that this was the eastern half of the vein just spoken of; it is supposed by some that the hanging wall fell in at the top.

Fig. 2 represents a horizontal section through a part of the Comstock Lode, showing the regularity of the course of the west or foot-wall, and the great irregularity of the hanging wall.

In Fig. 3 is presented a horizontal section of two bonanzas or chimneys of ore, and Fig 4 shows such a bonanza in vertical section, that is, as if the observer were looking northward through the vein. Bonanzas or ore bodies are generally found in the swells of the vein, and they usually traverse

the vein southward, and at a steeper dip than its own. As will be noticed, the form of its horizontal section (that is, what would be seen if we suppose the top to be cut off perfectly level, and the observer to look vertically down upon the top of what is left), is rudely lenticular or egg-shaped. In fact, if we take an egg, and hold it horizontally—the ends pointing north and south—suppose the depth to be about 500 feet; width about 10 to 100, and length from end to end, about 650; we will not have a very fallacious idea of a bonanza. The original Gould & Curry bonanza was of these dimensions. The fine Savage, and Hale & Norcross bonanza, was about 800 feet long, but not so wide as the G. & C. The Imperial, Chollar, and the wonderfully rich Ophir and Mexican, had each a splendid body of ore, as also the Belcher and Crown Point, whose body of ore, on the 1,100 level, about the center of the body, reached as high as 150 feet in width, and the enormous value of $2,000 a ton for about half a level of 100 feet deep.

The ore of the Comstock, whose valuable constituents are silver and gold, does not by any means all present the same appearance or constitution. There are three principal kinds of ore; one is the black sulphuret of silver, which is composed of sulphur and silver, and is usually found in an amorphous condition, that is, without crystallization, and sometimes contains considerable gold with it—although not often apparent to the eye. The blackish propylite before mentioned is often taken for this ore by visitors in the mine; but they may be distinguished by the fact that the ore presents a jet black, living appearance, while the propylite or "waste" rock has a dull look. The sulphuret of silver, also, occurs occasionally in small crystals of a cubical or octahedral shape, and can be cut like lead with the knife, which it also somewhat resembles in appearance; it is then called Silver Glance. An antimonial sulphuret of silver, called Stephanite or Brittle Silver Ore, sometimes occurs, but is rare; and the Silver Glance is often mistaken for it, even by those who should know better. The Stephanite is easily distinguishable by the fact that it is brittle, and for this reason cannot be cut by the knife like Silver Glance, but breaks off. Another thing is, the great purity of the Comstock ores from arsenic, antimony, lead, and zinc has permitted the use of the simple pan-amalgamation process by quicksilver for the reduction of their gold and silver, which could not be the case if any considerable amount of antimony were present in them.

The second kind of ore is the yellow sulphuret. It is the common bisulphuret of iron or iron pyrites, and is of a whitish to yellowish color and shining. It is sometimes called "fools'" gold, because novices mistake it for that metal. It is often associated with a little copper pyrite—the sulphuret of copper, which is still more yellow, and similarly shining. But the iron pyrites, although it must not be confounded with the gold itself, still is the ore which principally contains the gold of the Comstock, and, indeed, it may be said here that this is the same ore that contains nearly all the gold of the earth. The precious metal, however, is usually invisible in the pyrites.

The third kind of ore is the Chloride of Silver. It is white and light green, and is composed of silver and the gas chlorine. It is very rich in silver, but contains little gold with it. Where it occurs compact, it is called Horn Silver, because it can be cut like horn or lead.

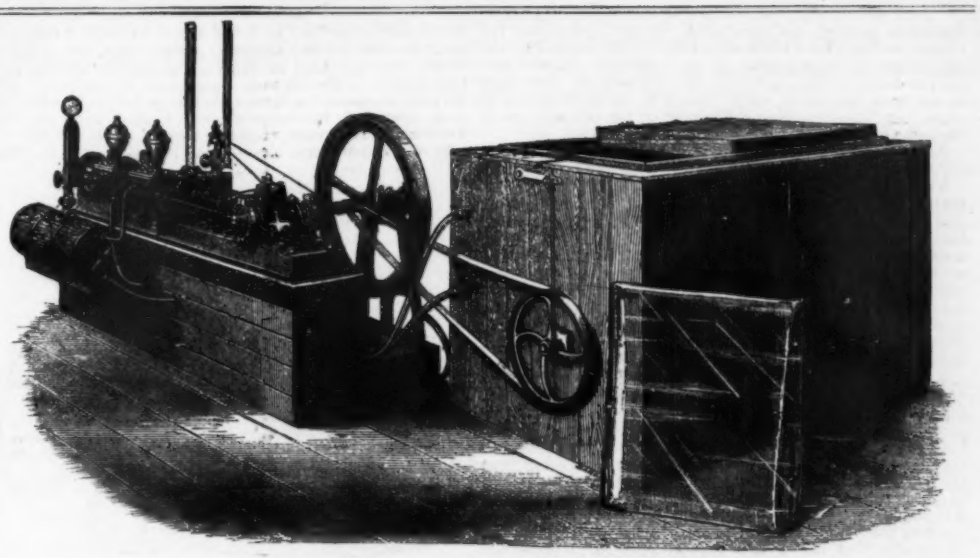
Besides these three principal kinds of ore, there sometimes occur minute bits or crystals of ruby silver ore (a compound of silver or sulphur with arsenic or antimony), and in the rich places small quantities of free gold and native silver occur; but these are the exceptions, and not the rule.

The gangue or matrix which holds the ores in the Comstock vein is *quartz*, with often considerable chalky carbonate of lime and sulphate of lime or "gypsum." Although the quartz often occurs crystallized in fine hexagonal or six-sided prisms and pyramids, and some pretty specimens of fibrous and crystallized gypsum are sometimes found, the *ore* of the Lode is remarkably free from crystallization.

Mt. Davidson and the other hills in all directions are dotted here and there with mound-like heaps of rocks of a light grayish tint, which mark the places where prospecting shafts or pits have been "sunk," or dug out. These are merely circular holes, generally about 10 feet in diameter and 50 to 80 feet in depth, and are untimbered.

Owing to the false dip to the westward of the eastern half of the vein, as shown in Fig. 1, the dip of the entire vein was originally supposed to be westward, that is, that it would cut through the center of the mountain, and this supposition was acted on, although it was clearly to be seen that there was another line of outcrop (*b* in Fig. 1) some hundred feet above and to the west of the line of outcrop *a*. But when in sinking, the west or footwall was reached, and the shaft sunk still deeper, it was found that the hard sienite, of which Mt. Davidson consists, was encountered; and that in running a level or drift through this intensly hard rock, westward to *c*, where the vein, if it dipped westward, should have been found, no vein was there; but that, in running a tunnel or drift eastward to *d*, the vein was discovered. Hence further exploration by the original shafts was abandoned, not only on account of the fact that every succeeding 100 feet downwards the vein would be at a rapidly increasing distance from the shaft, but also because of the very great cost and hard labor that was required in traversing such exceedingly hard rock.

New shafts, like that shown in Fig. 4, were commenced by nearly all the companies on the Lode, about 1,000 feet east of their original ones, and on the site of the new shafts new hoisting works were forthwith erected. These shafts vary considerably in depth, owing to the difference of level of the surface from which they are begun. They are sunk vertically, and usually go down through and under the vein. They are commonly sunk 50 to 100 feet further, when, as a rule, an "incline" or inclined shaft is begun in the footwall—upward, to connect with the vertical or "downright" shaft, and downward, about 150 to 175 feet, which is the equivalent on the dip or incline for 100 feet vertically downwards. From this point in the incline, a tunnel or "drift" is run eastward to the vein to find it, and through its cross section or thickness to explore it. When the eastern clay, before spoken of, which bounds the vein, is traversed, the miners return to the point of the drift, which is immediately to the west of the vein and in the footwall, and from there they commence a north and south drift, which is either entirely in the footwall, or else half its section in the footwall and half in the vein; and this is driven both ways, northward and southward, to the extremities of the claim of the particular company. This drift, in case it is driven in the footwall, is said to be "in the firm" or "in the solid," because it is in firm or solid ground. At several points along this drift, say at every hundred feet, cross drifts are driven eastward to explore the vein. From the north extremity of the main drift north, and also from the south extremity of the main drift south, the miners begin to pick and blast out



IMPROVED ICE MAKING MACHINE.

ore, and they work in the vein towards the incline, up which the ore is sent to the downright shaft, through which it is hoisted to the surface. The men timber after taking out the ore, and other men follow behind them and above them, and standing on timbers take out the ore higher up, letting it fall down to the drift below, where it is carried to the surface as before. So again another set of men follow these, but still higher up, and so on, till the entire depth of a hundred feet of ore, from the main drift up to the level of the bottom of the downright shaft, has been removed and hoisted. Meanwhile the incline has been carried down by other men a hundred feet deeper, and the same process repeated at that level.

The foregoing is a very general view of the mining operations below ground—the most that can be presented in this one article. But a particular and clear view will be given of each and every part and detail of the work, above and below ground, in succeeding articles, so that a far better and more thorough knowledge of the entire subject will be secured by our readers than if they were to merely go upon the ground and visit the mines, and see what little they could for themselves; for even those who have been in the mines on a visit have a very meagre idea of how they are worked. They know they have been underground, through an intricate series of passages, and traveling along some ladders, and on a car or "giraffe;" that they have seen picks and drills and shovels, but they rarely retain anything but an exceedingly confused notion of these, together with a remembrance of great heat, half-clothed men, hard work, rock, candles, and cars.

NOTE.—The first quartz claim on the Comstock Lode was located on the 22d of February, 1858, by one James Finney, who was nicknamed "Old Virginia," the croppings being called the "Virginia Croppings," and it was from him that Virginia City took its name. The first discovery of rich silver ore on the Lode, however, was not made till June, 1859, when two Irishmen—O'Reilly and McLaughlin—found a rich vein of black sulphuret of silver on the ground of the present Ophir Company. This ground being owned at the time by Kirby and others—placer miners in Six Mile Canyon below the Ophir works—one Comstock was sent to purchase it from them, and the entire Lode has since been called the "Comstock."

It is to the discovery and development of this gigantic Lode that the great impulse to quartz or vein mining in the West was originally due. The wonderful richness of that vein at once attracted immigration of miners from all quarters, and much attention from scientific men—among them notably the learned Baron Richtofen. Claims were quickly taken along the Lode in lengths of 50 to 1,200 feet, until a total distance of about two and a half miles had been located, which has now been greatly added to in both directions—north and south. The yield of gold and silver from the Ophir and other mines soon became enormous, more especially after the crude methods and instruments of mining had been replaced by a better system, as well as suitable and powerful machinery.

The following table presents the annual and total yield of bullion from the entire Lode since its discovery:

Years.	Yield.
1859 to end of 1865, estimated	$80,000,000
1866	11,732,100
1867	13,636,063
1868	8,499,769
1869	7,528,607
1870	8,321,538
1871	11,053,320
1872	11,897,612
1873	21,544,727
1874	22,400,788
1875	26,000,000
1876 estimated	35,000,000
Total yield to end of 1876	$257,604,508

Of this the Belcher Mine alone produced bullion from June 1st, 1871, to Dec. 3d, 1874, to the amount of $16,772,965.

Taken as a whole, the Comstock has proved itself the most valuable silver and gold bearing Lode in the world.

IMPROVED ICE-MAKING MACHINE.

THE perfection of mechanical and scientific ingenuity in the present day has reached to such a point that we have now long passed the narrow limits of seeking only to effect by mechanical means necessary or laborious operations, but even luxurious requirements are now so produced.

Ice has now become a necessity of the age, not only for ordinary domestic use, but for a large number of new applications which had not been thought of until lately. Amongst these are the invaluable use of ice to enable shipments of dead meat to be made from America. By this means the meat is preserved from taint, and a supply of first-class beef can be brought to our market at nearly half present prices. Another special adaptation of ice in a large quantity is born of a modern luxury—to supply artificially, and independently of Jack Frost's late puny efforts, a floor of ice upon which that most beautiful and exhilarating of sports—viz., skating—may be enjoyed. In summer, too, no hotel, eating-house, public-house, or private dwelling is considered as supplied with all that is needful unless ice is to be had for the cooling of liquids or keeping of fish, etc.

To meet these many and various demands, a most important class of ice-making machines have now been for many years in existence and successful operation. Amongst these the machines of Messrs. Sideley & Mackay, Liverpool, are justly renowned for their efficiency and successful operation. The whole plant is shown in our engraving, with the exception of a steam boiler to drive the engine.

The principle of this machinery is simplicity itself. The mechanical effect of steam power is used alternately to expand into gas or evaporate some volatile liquid such as ether, and then again to compress it back to its liquid form. In the process of expansion or evaporation, a very large quantity of heat is absorbed by the vapor in its change of form, and becomes latent. This heat is taken from the surrounding materials, causing an intense decrease in their temperatures. It is at this period of the process that brine, or other non-freezing medium, is brought into contact with the vaporizing liquid and its heat-absorbing properties. The non-freezing medium is thus robbed of its normal amount of heat, and is brought down to a temperature considerably below zero centigrade. The brine may be then caried off by suitable circulating pipes to effect the congelation of water, or for any other purpose, returning to the machine to be re-cooled.

After the ether or equivalent medium has been vaporized, it is necessary once more to recondense it to cause a continual recurrence of the operations with a single supply of volatile liquid. When this recondensation is effected an amount of heat is rendered sensible by the compression in excess of the normal temperature of the liquid. This excess of heat above the ordinary temperature of the atmosphere must be carried off from the recondensing vapor to bring the ether back once more to its normal condition and temperature, and make it suitable for being used over again.

The carrying away of the excess heat is effected by contact with a constant supply of water at ordinary temperature. The apparatus by means of which these operations are carried out are equally simple and surprisingly effective: an ordinary engine, with steam cylinder, as the prime mover, and a flywheel to steady its motion. Upon the same bed-plate is bolted an air or vapor pump, which is supplied with suitable valves to draw out the vapor from the vapor-chamber, and then to deliver it to a suitable chamber for recondensation. The ether-evaporating chamber is the lagged cylinder, which may be seen in the illustration supported upon brackets to the side of the foundation of the main engine. The liquid ether is stored in this chamber, and through it run very small tubes, similar to the construction of a surface-condenser, and through this tubing is made to circulate the brine or non-freezing medium. This enters the tubes at one end, and the connection to the freezing tank is plainly seen in the illustration passing through the foundation, and also its point of exit from the top of the freezing tank. The circulation of this brine or non-freezing-medium is effected by a single-acting plunger-pump of small diameter, plainly seen upon the engine bed-plate, and driven by an eccentric from the flywheel shaft. The suction-pipe to, and the delivery-pipe from, this pump passing down through the foundation, and entering the freezing tank, are all clearly shown in the engraving. A second pump, of similar construction to the brine-circulating pump, is also to be seen upon the bed-plate, and may be made use of for the supply of ordinary water to the condensing vessel.

The evaporation of the ether is effected by the vapor-pump, which is bolted to the engine bed-plate, and is worked by the piston-rod of the engine, being carried direct through the back cylinder cover, and the vaporized gas is drawn through the syphoned copper suction-pipe seen rising vertically above the freezing cylinder, and with a gauge fitted to it to show the vacuum produced. This vapor is then delivered on the other side—where another gauge shows the amount of compression—into an open cold water tank, through which the ether vapor is made to circulate in small tubes, and in which the excess heat is carried off by the constant supply of cooling water to the tank.

The economic action of the machinery very largely depends upon the perfection of the vapor-pump, that a maximum suction draw and a perfect and total delivery over of the volatilized vapor is truly effected in every stroke. To effect this requires intelligent and ingenious construction in the vapor-pump, valves and valve-boxes, and the perfection of the action of Messrs. Sideley & Mackay's pump was very indisputably proved by the most excellent diagrams taken therefrom, some of which we personally inspected. The rising curve of pressure is most perfect and regular. The contrast between the evaporating and compressing sides of the machine is most startling. The freezing chamber is

lagged to prevent the absorption of heat, and upon the copper suction-pipe a white-frost rime will be formed by the exceedingly low temperature of the vaporized ether within. On the delivery side, however, the temperature is so high as to burn the hand when placed on the delivery box or pipe. And these startling differences of temperature are in the same material and within a foot of each other.

The arrangements of the freezing tank itself are almost as important for success as those of the engine or pumps.

The great specialty and success of these machines is the peculiarly clear blocks of ice produced in them, as is so graphically shown in our illustration by the transparent block some six inches thick. This effect is not easily attained, as, for the most part, artificial blocks are full of air-bubbles; but it has been in this case insured by a constant agitation of the water whilst freezing, so that all the air-bubbles are driven out. This agitation is effected by a rocking beater or arm in each cell, which are operated, as shown, by a band-driving wheel from the engine to a crank arm.

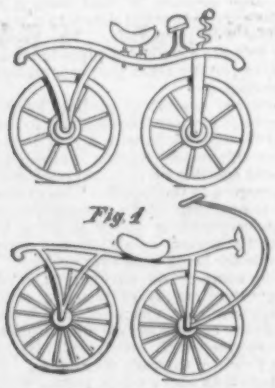
The partitions of the cells are made hollow, vertically, 1 or 2 inches thick, in which the non freezing medium, viz., the brine, is made to circulate by suitable connections. The form of these intermediate divisions is so important that it has been made the subject of a patent. In the first instance they do not form a parallel space between each other; but the frozen block is smaller at the bottom than at the top, so that it draws with ease when released. In the second place it is important that the cells should entirely surround the freezing blocks, not only for the most effectual freezing, but principally that the release may be effected all round the block. The flat cells have each thus T-heads, like firebars, so as wholly to inclose the space between them. The release is effected by replacing the circulation of the freezing brine by a reverse circulation of brine at ordinary temperature. A little surface melting is thus effected over the whole block and it readily draws away from the cells.

We had the pleasure of personally inspecting the operation of one of these machines under most trying circumstances, viz., in the hottest of summer weather, and we can here state that the effective results somewhat surprised us. We understand that the efficiency of these machines has made a commercial success of at least one Artificial Ice Supply Company, where the blocks are made some 12 inches in thickness and quite clear and hard, each block weighing about 7 cwt.—*Iron.*

THE BICYCLE.

By PADDLEFAST.

No locomotive device is more bold in design, or more facinating in use, than the bicycle; not the old-fashioned, heavy, rickety, wooden concern that jounced and vibrated so provokingly, and periodically broke down, but the light, beautiful, steel, rubber-tired bicycle of modern make that runs as smoothly as a sleigh, requiring so little exertion that a forty mile journey on a country road is made in four hours, without fatigue. Many visitors to the Centennial Exposition



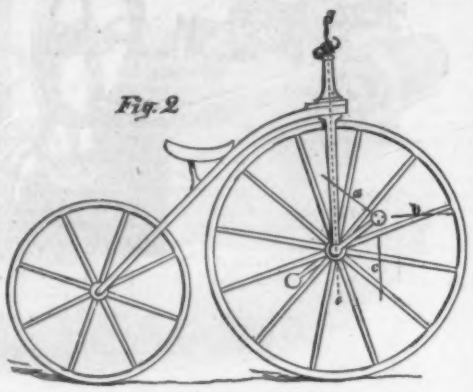
THE FIRST BICYCLES.

remember the gigantic bicycle, with driving wheel seven feet in diameter. It seems suicidal to attempt to ride such a monster; yet the machine exhibited has been ridden with ease at a speed of 20 miles per hour.

The modern bicycle is not merely a plaything. It is used by some country physicians, and it is the testimony of one medical gentleman, who travels many miles per day, that he finds bicycle riding cheaper, more rapid, and less fatiguing than horseback. The novelty in Europe is a bicycle journey from St. Petersburg to Paris, already undertaken by a gentleman who was reported, some time ago, as having reached Berlin. Last year, tours were made on the bicycle all over Great Britain and Ireland and many parts of the Continent, and a "Tourists' Club" is forming to enable members projecting a tour to secure agreeable companions.

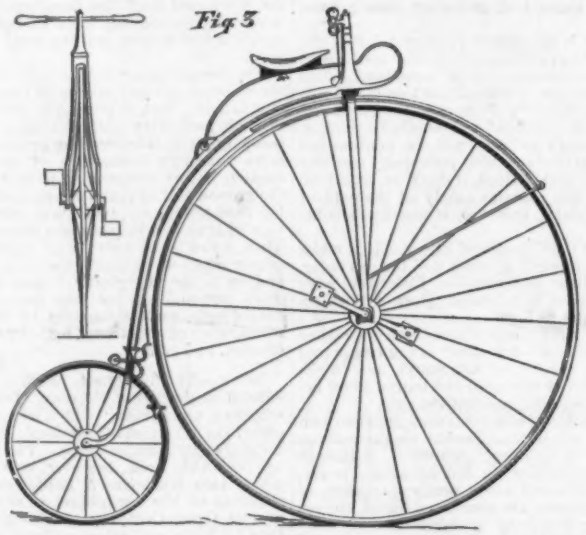
Bicycle riding is so quickly learned that a gentleman tells us he rode over a quarter of a mile in the third lesson. The ease with which the improved bicycles run is such that another enthusiastically declares, "I can ride 40 miles before dinner and 40 after, without fatigue." One hundred and sixty-six miles were traveled in one day, and the rider even survived, but admitted being "rather tired." The greatest distance ever made in one day is claimed to be 200 miles. A journey of 660 miles was made in six days; and a party of gentlemen made a very agreeable 17 days' tour along the south coast of England, during which time not a breakdown occurred, and not a nut loosened. The united expenses of the three persons were £18. The durability of these vehicles is remarkable, despite their frail appearance. A gentleman, well known in bicycling circles, says: "I have been over 15,000 miles at least, over the worst roads in Ireland and other parts of the United Kingdom alone, without saying anything of the Continent. The 'Ariel' wheels have without repair, save once when I fell, met the extreme wear and tear of the above." A speed of 12 miles per hour is not thought uncommon, and a mile has been run in 2 minutes 48 seconds. Many excellent feats have been performed by amateurs.

After such performances our duty is clear. Nature having made a woeful slip in furnishing us legs instead of wheels, we must supplement our deficiencies with "Coventry spiders." In view of the fact that the bicycle is to inherit the world, a short history of the machine is in order. It had a rude beginning, as Fig. 1 will show, which is a copy of a print in the British Museum. Such were the machines which were patented in France, and introduced into England in 1818, but were soon laughed out of existence. And with good reason, for these rude things had no treadles, and were propelled by thrusting the ground with the feet. Thereafter, numerous valueless patents were granted. In 1862 the old wooden bicycle was invented (Fig. 2), which



THE BICYCLE OF 1860.

immediately became the rage. Now, looking from the heights of steel "spiders," we class these cumbrous things as quite medieval. In 1874, wood was entirely superseded by metal, and now the best "roadsters" weigh but 40 or 50 pounds, in contrast to 80 or 100 pounds of the old style. In the early part of 1876, there were eleven bicycle clubs in London, and forty-five in the rural sections of England, but during the last year their number has trebled. The English



THE "PARAGON."

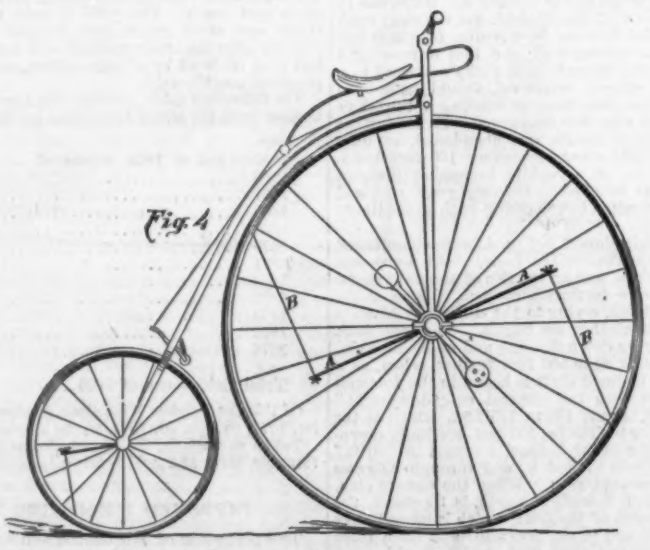
bicycle interest now supports two newspapers and two magazines, devoted entirely to the subject.

The leading English bicycles are, the "Paragon," made by C. D. Roberts, Coventry, and the "Ariel," the "Tangent," and the "Swiftsure," manufactured by Haynes & Jefferis, same town. The wheels of the Paragon, shown by Fig. 3, are constructed on the "spider" principle, each spoke having an independent tension. The felloes are of angle or V-shaped iron, into which a round ¾ inch hoop or tire of pure india rubber is securely cemented. The hubs are solid forgings. The backbone is hydraulic tube. The spring terminates in a roller moving on the backbone. The wheels run on conical bearings which retain the oil, and prevent lateral shaking consequent upon wear. The brake is a roller, concaved to fit the rubber tire, and applied by a lever to the small wheel. From this lever runs a cord up the backbone, under the saddle, then vertically to the handle shaft, round which it is wound by revolving the handles. When the tension of the cord is relieved, a spring on the lever throws the brake from the

A defect of the old bicycle (Fig. 2), which was, that vigorous action of the leg tended to throw the rider backward from his saddle, is overcome in the modern machine, the whole weight being applied to the pedals. Then, too, in the old vehicle, the power being applied alternately to the opposite pedals, and in a diagonal, not vertical, direction, the effect was similar to a horizontal pressure against the steering handle, first on one side and then on the other; or, referring to Fig 2, the power acts against the pedal in the direction of the arrow *a*, but, being resisted by the friction of the whole vehicle, it is resolved into two other forces, represented by arrows *b* and *c*. Force *b*, being applied on one side of the wheel, evidently tends to turn the wheel on its steering axis *d e*. When, at the next stroke, the power is applied on the opposite pedal, the deviation of the wheel is reversed. A provoking vibration was thus produced in the old machine, which is obviated in the modern by applying the propelling force almost parallel to the steering axis.

The objection to the spider wheel is a certain elastic movement between hub and felloe, so that when power is exerted the wheel "gives." This evil is keenly felt when ascending hills. The Ariel wheel, like the Paragon, has separate round charcoal iron spokes, but the tension of these is maintained by a special patented arrangement. A lever A A, Fig. 4, is rigidly fixed to the hub; the arms, B B, are shortened by screw nuts; the hub is thereby slightly revolved, and thus the spokes are submitted to any required tension.

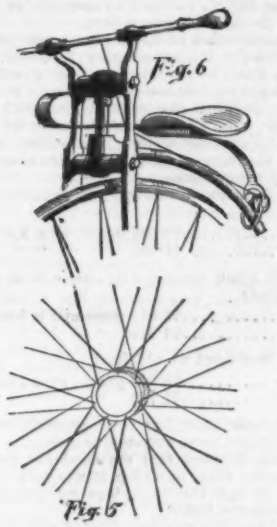
This wheel is quite rigid and receives much commendation, but the lever being somewhat unsightly, and so much extra weight, the manufacturers have lately patented the "Tangent" wheel, Fig. 5. These spokes mutually cross and lock, and prevent all movement between hub and felloe. The Ariel machine is specially adapted for very rough roads. The Tangent is claimed to be the lightest reliable bicycle made; the "racer" weighing only 28 lbs., and the "roadster" from 35 to 45 lbs., according to size. The old-fashioned fork arrangement of the steering apparatus (Fig. 3) is liable to heat and become set, it is stated; hence the peculiar construction of the Ariel and Tangent machines (Fig. 6), which is claimed to possess superior strength and lightness with less friction. These bicycles are fitted with detachable self-lubricating bearings of gun metal, or, at an additional expense, with patent anti-friction bearings, which require no oiling. The pedals are steel bushed, and clothed with rubber; the latter improvement, combined with the rubber tire, and the neat arrangement whereby the saddle is placed in the middle



THE "ARIEL."

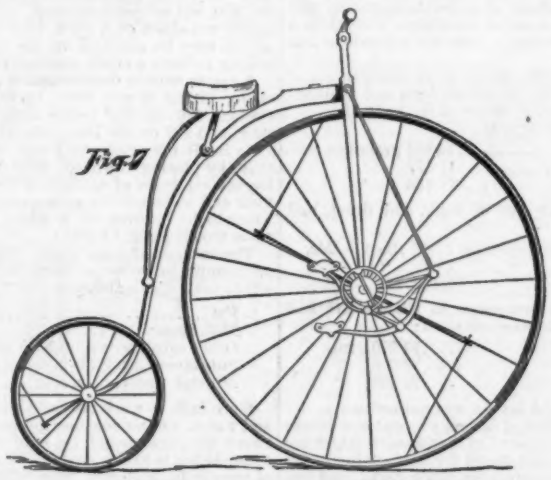
of the spring, certainly entitles the Ariel to wide reputation for easy and comfortable riding. The machines are constructed throughout, as far as possible, so that they may be put together by unskilled hands, and broken spokes or other parts replaced by the rider in a few moments. It seems universally acknowledged, however, that even slight repairs are seldom needed.

The "Swiftsure" is a simpler, cheaper machine, with spider wheels; in other respects similar to the Ariel; and in workmanship and durability the makers claim it is nowise



inferior. It should be noticed that there are many machines in the market closely resembling those herein described, but their durability is generally very questionable.

Messrs. Haynes & Jefferis manufacture the only ladies' bicycle (Fig. 7.) As there is but one lady bicyclist known in England, this machine requires little notice. It is fitted with



THE "LADY'S" BICYCLE.

all the "Ariel" improvements, with the addition of a dress guard. The rider sits on the left side of the driving wheel, and the back wheel runs about 15 inches to the left of the

front wheel track. The arrangement is that of a four-wheeled vehicle with the left front and right back wheels removed. The propelling mechanism is a crank on the left side, with a double throw, and to avoid rotary motion of the feet, the pedals consist of a pair of levers, connected to the crank by a pair of links. By this arrangement the rider's feet are not exposed, and the machine runs equal to an ordinary bicycle.

The seven feet bicycle referred to was an "Ariel." The propelling device is shown in Fig. 8. So large a machine, however, is not advisable, even for speed. The following table gives the sizes in general use:

"ARIEL" PRICE LIST—GOLD.

Diameter of front wheel. Inches.	Height of rider. Feet.	Inches.	Price, Painted.
40	4	10	$80
42	5	0	82
44	5	2	84
46	5	4	86
48	5	6	88
50	5	8	90
52	5	9	92
54	5	10	94
56	5	11	96
58	6	0	98
60	6	2	100

Prices, polished all over, etc., 25 per cent. extra. Prices, nickel plated, 70 per cent. extra. There are various additional conveniences supplied extra, such as valises, lamps, etc. These are the prices charged by the American agents:

TABLE OF COMPARATIVE COST.

Of 50 inch	"Swiftsure,"	painted	$67 50
"	"Paragon,"	"	87 89
"	"Ariel,"	"	90 00
"	"Tangent,"	"	104 06
"	"Lady's,"	"	107 61

RULES FOR A PROVINCIAL CLUB.

1. The club shall be called the —— Bicycle Club, and the place of meeting shall be —— or such other place as the committee shall decide.

2. The officers of the club shall consist of a captain, secretary, treasurer, and two auditors.

3. The officers and three other members of the club shall constitute the committee. The three members shall be elected at every general annual meeting.

4. The committee shall meet once a week to transact the business of the club, and four shall form a quorum.

5. The committee shall be the governing body of the club; shall have power to call special meetings of the club; to expel any member of the club upon due cause being shown; to suspend any officer; to appoint meeting days and excursions; to manage and control the expenditure of the club; to arrange for races, etc.

6. In every case the decision of the committee shall be final, unless notice of appeal, in writing, be given to the secretary by any member, whether aggrieved thereby or not, on or before the next meeting of the committee.

7. In case of vacancy occurring among the officers or members of the committee, the committee shall immediately appoint another in the stead of the one suspended or vacating office, and the officer or member so appointed shall hold office until the next general meeting, when he or some other member shall be duly elected thereto.

8. The captain shall preside at all meetings. He shall immediately on election appoint a deputy, who shall preside in his absence.

9. The secretary shall, if possible, attend all meetings, and, if absent, shall appoint a deputy.

10. The treasurer shall report at every committee meeting the amount of money in hand, and shall obtain the instructions of the committee as to all necessary disbursements.

11. Each member shall pay an entrance fee of 60 cents, and a quarterly subscription of 60 cents, to be paid in advance.

12. A sum of money, not exceeding one third of the annual revenue of the club, shall be expended in prizes, to be competed for by members only.

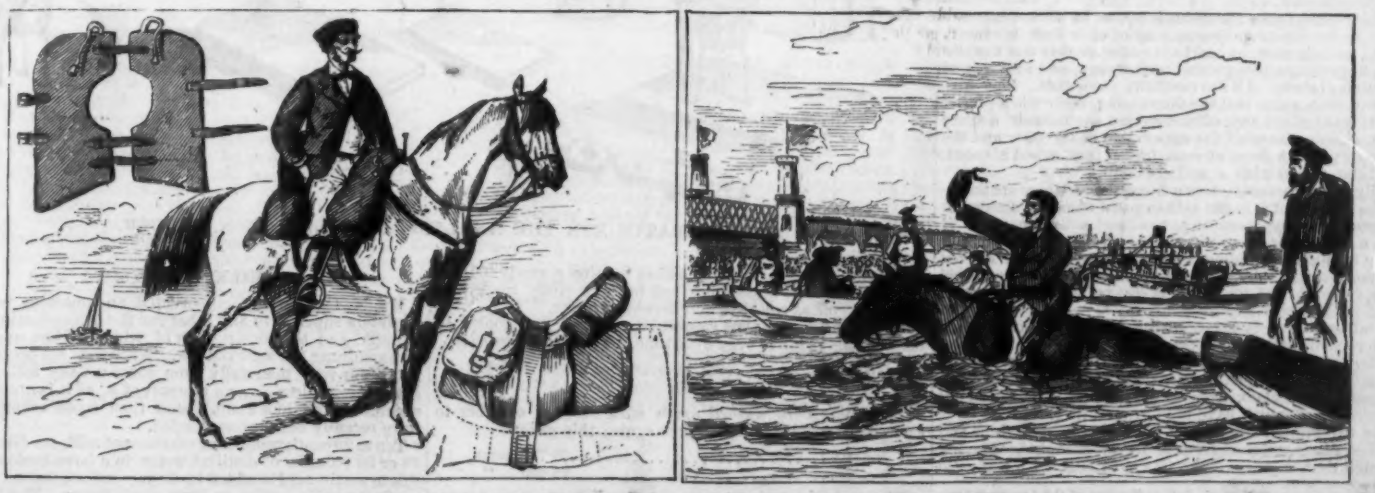
We are indebted for much of our information to Messrs. Lawford & Timms, sole American agents of the English bicycles, P. O. box 504, Baltimore, Md.

THE AGE OF THE EARTH.—In his address, as President of the Liverpool Geological Society, England, Mr. T. M. Reade offered some data for calculating the length of geological periods. He made a careful estimate of the amount of solid matter washed down by the Thames per year, the figures very closely agreeing with those which Prestwich obtained. Similar calculations were made by Mr. Reade for other rivers. The Thames is credited with washing away 147 tons per square mile every year; the Rhine, 92·3 tons; the Rhone, 239 tons; the Danube, 72·7 tons; the Garonne, 142 tons; the Seine, 97 tons. Probably throughout the world 100 tons of rock material are dissolved per square mile every year, of which half may be calcium carbonate, a fifth calcium sulphate, seven tons silica, of magnesium carbonate and sulphate and sodium chloride four tons each, and six tons of other alkaline carbonates and sulphates. Taking the solids removed mechanically at six times those in solution (a high estimate), the total denudation on the globe would be 600 tons a year per square mile. One third may be added to this for denudation effected by the sea on its coasts and for the amount that vulcanic eruptions add to a given stratum. Carrying out this calculation for the sedimentary crust of the earth, estimated at 10 miles in thickness, its production may have occupied 526,470,000 years. This evidently includes the assumption that the denuding action was as slow in distant geological epochs as at present. It should not be difficult to calculate from such data the number of millions of years that must elapse before our present continents are worn down to sea-level. Such a deduction would compel a very great modification of some of the figures assumed by M. de Candolles in his recent estimates as to the length of time that the earth will be fitted for the abode of man.

PANTOPOLLITE.—An explosive has been introduced under the name of pantopollite. It consists of nitroglycerin dissolved in naphthalin. The fumes developed on its explosion are extremely distressing, producing violent pain in the head and chest.

NEW CAVALRY LIFE PRESERVER.

LIEUTENANT FEODOR VON ZUBOVITZ, of the Hungarian cavalry, has invented a new method and a simple apparatus for the use of cavalry in crossing a deep river; and in the presence of many thousand Viennese spectators, he recently gave an exhibition of the performance, near the Prince Rudolf Bridge on the Danube. He had ridden across the Danube, in this manner, above sixty times before, and had been seen by large multitudes of his countrymen at Buda-Pesth, invariably doing it with complete success. The nature of the appliance he has contrived, its arrangement and its manifest efficiency, will be shown, almost at a glance by our two illustrations, from the sketches of a Vienna correspondent. A pair of india-rubber bags, to be inflated with air like ordinary air-cushions, but of the shape figured separately in a corner of the first engraving, connected by two straps behind, over the horse's crupper, and by one strap in front of the saddle, with two pairs of belly-straps, to be fastened, like the girth, under the horse's body, will suffice to hold up both horse and rider in the water, needing only the slight effort required to direct their course Not above half the horse's body sinks in the water, so that the entire saddle, and the man's body and thighs—all in fact, above the man's knees—will remain quite dry, with his knapsack and cartridge-box, his weapons and other accoutrements, free from risk or damage. The india-rubber bags, when not inflated, form a covering for the pommel and crupper, serving to protect the saddle from rain; but when the soldier has to ride across deep water he can fill them with air, in one minute, by raising to his mouth the two small flexible tubes attached to the front of these bags, without having to dismount or stop his horse. It really does seem remarkable that nobody has thought before now of such a very simple and obvious method for helping a horse to swim. There are many English hunters, we believe, which can, with some difficulty, in swimming, carry a rider of moderate weight for an extremely short distance; but only the horse's head and neck, and the man above his waist, can be kept above water, unless by some artificial aid.—*Illustrated London News.*



NEW CAVALRY LIFE PRESERVER. BY LIEUT. FEODOR VON ZUBOVITZ.

THE ANALYSIS OF MILK.*

By E. H. VON BAUMHAUER.

ALL things considered, the best material to mix with the milk to facilitate evaporation is incontestably pure sand washed with hydrochloric acid, as suggested by Otto,

Select sand which is quite white and clean; better yet would be colorless quartz in powder. Digest the sand with hydrochloric acid, wash well with rain water at first, and lastly with distilled water, until the latter yields no trace of acid. This may be prepared on a large scale. Dry the sand, and ignite in a clean covered Hessian crucible, and while still red hot pour the contents from a certain height upon a clean stone in order that the organic matter carbonized during the ignition may be burned while falling through the air. After cooling, place the sand in clean bottles previously dried, and cork well; thus the sand may be preserved for use.

The filter paper, cut in disks of 10 to 12 cm. in diameter, is also washed with hydrochloric acid and water, then dried in a current of dry air, raising the temperature at last to 110° C., and finally preserved in wide-mouthed bottles closed with rubber corks.

A disk of copper standing on feet 10 cm. in height (see Fig. 1) is pierced with ten, twelve, or a larger number of round holes having a diameter of 5 cm., and placed at a certain distance from each other. In these holes are hung rings made of glass rods, the diameter of the rings being 4 cm., and that of the rods 3 mm.; these rings rest on the copper disk by means of little curved arms of glass soldered to them.

Fig. I.

Fig. II.

Fig. III.

ANALYSIS OF MILK.

Subsequently I employed rings made of baked clay. In each of these rings is placed a filter folded in quarters in the usual manner, and filled with sand up to ¼ cm. of the edge: this step only required a few minutes. Near each hole a number is scratched upon the copper disk; in the center of the disk a wooden handle is fastened, by means of which the disk, with its load of sand-filled filters, can be handled with ease; the disk also has a small hole near the circumference, through which a thermometer is introduced.

The heating apparatus consists of a copper bath with double walls, between which is placed paraffin; in this air-bath one or two copper disks above described, and which I call *supports*, are inserted one above the other, as shown in the cut; A and B have each ten holes, so that twenty filters can be dried at one operation.

The cover of the bath fits closely, and carries at its center a small tube, which is covered about with wood, and serves at the same time as a handle; this tube is connected with a Woulfe-bottle, C, in which the water-gas condenses, and which is joined to a strong aspirator, such as I have described in the *Archives Neerlandaises*, vol. i., p. 191.

The cover is pierced with another opening, in which is fastened a thermometer; the bulb of this thermometer, passing through the holes in the *supports*, reaches to a level with the points of the lower filters. Between the double walls of the bath is fastened a copper tube, bent twice at right angles, and terminating at one end in the middle of the air-bath, while the other end is connected, at the close of the operation, with an apparatus for drying the air over sulphuric acid or calcium chloride.

As many glass flasks and funnels are required as there are analyses to be executed; the capacity of each flask is exactly 100 c.c., as indicated by marks on the necks: the funnels (Fig. 2) have their edges ground with emery, and are covered with watch glasses. All are carefully numbered. The funnels are of such a size that the filters hang freely when placed on the rings of glass, and, after covering the funnels, a space of ¼ cm. remains between the upper edge of the filter and the glass cover; to the stem of each funnel is attached a caoutchouc tube, closed with a spring-clamp.

Finally, as many desiccators are required as there are analyses to be made, for it is not safe to use a common desiccator for substances as hygroscopic as the fixed solids in milk. I use as a desiccator or receiver a beaker glass, in which is placed a triangle for supporting the rings with their curved arms, above described. At the bottom of the glass is placed calcium chloride, and the whole is covered and closed with a hood of india-rubber.

The milk analysis is conducted as follows: Having filled the filters with sand, place them on the support, and heat them for half an hour in the air-bath at 110° C.; after cooling them in the desiccators, weigh them, successively placing on a small beaker glass, from which the bottom has been cut and the edges of which have been ground (Fig. 3).

In my experiments the beaker glasses with glass rings and sand-filled filters weighed from 68 to 75 grammes. Having completed the weighings, take 10 c.c. of milk with a pipette from each of the samples, the temperature of which has previously been brought to 15° C., and add the milk to one of the filters, taking care to moisten the whole surface of the sand, save the exterior edge.

The sand on the filter can absorb more than 10 c.c. of milk without the point of the filter becoming moistened; on some occasions a few drops of liquid ran from the point of a filter, but this was when I had to deal with milk adulterated with an equal volume of water. In case this happens, the filter is replaced by another, to which only 5 c.c. of milk are added; then, after the filters are nearly dry, the other 5 c.c. are added, and the dessiccation continued. In making analyses, I continually worked with 10 c.c. of milk, and I calculated the results as parts in a thousand by volume—that is to say, in a litre. I think this method of procedure is more rational than to give the composition in hundred parts by weight, when we consider that milk is sold by measure, and not by weight.

When all the filters have been charged with milk, the support is placed in the air-bath and the temperature is raised to about 60° or 70° C., which heat is maintained so long as the current of air which passes through the apparatus deposits moisture in the Woulfe-bottle. After this the aspiration is moderated, and air previously dried is passed through the apparatus, which is then heated to 105° C. for a good half-hour. The desiccation is entirely completed in 4 to 5 hours, without the necessity of giving it any attention, save to examine from time to time the stand of the thermometer. The filters are then allowed to cool one hour in the receivers, and weighed again. The difference between the first and second weighings gives the sum of the fixed constituents of the milk. For greater precaution the support may be replaced in the air-bath and heated an hour longer at 105° C., again cooled and weighed, in order to make sure of complete desiccation; but if the process described has been followed closely, it will always be found that the second weighing differs from the first by only 1 (or at most 2) milligrammes, more or less. Care must be taken not to remove the filters too soon from the receivers, since sand cools very slowly.

It is also of the greatest importance to avoid a higher temperature than 70° C. during the evaporation and before the filters are dry, since, if wet filters are heated suddenly to 100° C., their edges become immediately of a brownish yellow color; but by effecting the drying at a low temperature this does not occur. When the mass is once dry, it sustains a heat of 105° C. without browning. Otto has pointed out this fact previously.

As an example, I produce the results of an examination of asses' milk, collected in a stable at Amsterdam, and analyzed for the purpose of testing the accuracy of the method.

Three sand-filters, dried, weighed:

No. 1	74·883	grammes.
No. 2	71·577	"
No. 3	71·338	"

Each was charged with 10 c.c. of milk, and dried, and weighed again; this gave—

No. 1	75·981,	and consequently	1·098	fixed solids.
No. 2	72·672	" "	1·095	" "
No. 3	72·438	" "	1·100	" "

After drying the filters an hour longer in the air-bath and cooling, the following figures were obtained:

No. 1	75·980	grms.
No. 2	72·672	"
No. 3	72·438	"

It is evident that the second drying was not necessary.

To determine the proportion of fat, we proceed as follows: The filters with contents are placed in the funnels, which are filled with anhydrous ether and closed for half an hour; the ether is then drawn off by opening the pinch-cocks, and the operation repeated twice; the filters are washed twice more with ether and placed on the *support*, which is then introduced into the air-bath. Each filter requires scarcely 100 c.c. of ether. If the desiccation had been carefully made, the ether runs off as colorless and limpid as water.

Nos. 1 and 2 were thus treated, then dried and cooled as before; this requires very little time. The weighings gave:

No. 1	75·775	grms., or a loss of	0·206
No. 2	72·460	" " "	0·212

The filters were washed again with 100 c.c. of ether to each, dried, cooled, and weighed again; this gave

No. 1	75·775	grms.
No. 2	72·460	"

The first treatment with ether had dissolved all the fat. Some chemists recommend to evaporate the ethereal solution in weighed capsules, to dry the residue at 100° C., and to weigh it. I do not advise this method, partly because a loss results by the ethereal solutions creeping over the sides of the capsules, partly because I have found that fat dried in this manner at 100° C. partially evaporates, as is shown by the odor and the rise of white vapors.

For the determination of the sugar we proceed in the same manner as with the fat, substituting, however, warm water for ether; the water which filters through as collected in the 100 c.c. flasks above mentioned. By using 90 c.c. of water in successive portions the sugar is completely extracted. Since, however, casein is not entirely insoluble in cold and hot water, the filters lose weight by a second treatment with warm water; the second filtrate does not contain sugar, according to my experiments.

Nos. 1 and 2 treated in this way, dried and cooled, gave on weighing:

No. 1	75·035	grms., or a loss of	0·740
No. 2	71·730	" " "	0·730

After being again treated with 100 c.c. of warm water, dried and cooled:

No. 1	75·011	grms., or a loss of	0·764
No. 2	71·714	" " "	0·746

By a third treatment we obtained:

No. 1	75·004	grms., or a loss of	0·771
No. 2	71·700	" " "	0·760

When the desiccation has been properly conducted, the water solutions are quite colorless and clear.

The aqueous solution first obtained was cooled to 15° C. in the graduated flask in which it was collected, diluted to 100° C., and in this the sugar was estimated by means of Mulder's standard solution.

Ten c.c. of the test solution, diluted with 10 c.c. of water, required:

No. 1	5·25 and 5·30	of sugar solution.
No. 2	5·35 and 5·30	" "

The second filtrate obtained above was added to 5 c.c. of the standard solution, and on first boiling no reduction took place; but by continuing the ebullition a very slight one ensued—so weak, however, that after adding all the filtrates of the first and second treatment, making 400 c.c. in all, the liquid remained of a dark blue color. The reduction observed may be ascribed to the casein, which by prolonged boiling reduces a small quantity of the copper solution.

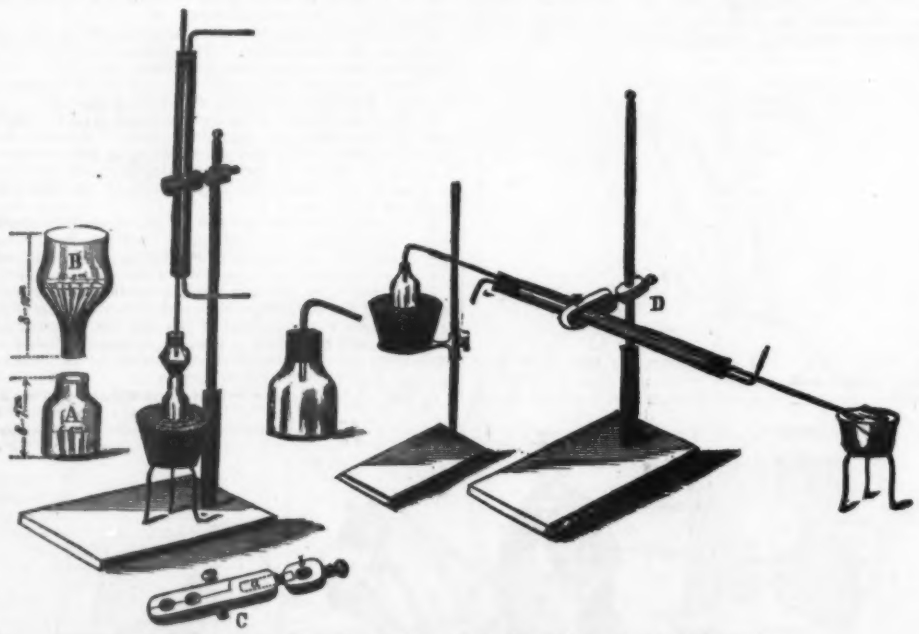
A creamometric determination of the asses' milk was also made, giving 3 per cent. by volume. The galactometer marked 110 on the yellow scale in the milk in its natural state, and 107 on the blue scale after skimming.

As in all my analyses, I also estimated the ashes of the milk, by placing 10 c.c. of milk in a platinum crucible, adding several drops of acetic acid (to prevent the formation of films and to hasten the evaporation), and evaporating on the water-bath, igniting to a white heat, and weighing. This gives 0·0355 grms. of ashes.

The analysis of asses' milk, which I have merely taken as an example in order to show the accuracy of the method, yields the following figures in a litre:

Fat	20·9	grammes.
Milk sugar	61·5	"
Other substances soluble in water	12·0	"
Substances insoluble in water	15·3	"
Mineral water	3·5	"

Since milk is a mixture of various non-volatile substances and water, and no constant proportion by weight exists between the constituents, the only way to determine its average composition is by the analysis of a large number of samples of pure milk, collected from different localities and from animals placed in varying conditions and submitted to different nourishment.



APPARATUS FOR THE ANALYSIS OF MILK. BY N. GERBER.

MILK ANALYSIS.

MR. N. GERBER has constructed an apparatus which he considers superior to any other for the determination of fat in milk, and the construction of which will be understood by examining the annexed cut. Although his process does not differ very materially from those usually followed, we shall nevertheless give an abstract of it, as it is quite easy of execution and less complicated than some others which have recently been recommended.

Ten to 20 centigrammes or grammes of milk are diluted with 20 or 30 volumes of distilled water in a large beaker. Very dilute acetic acid is added in drops, under constant stirring, until the milk begins to form small flakes. The beaker is now set into water of 75° C., and allowed to remain therein

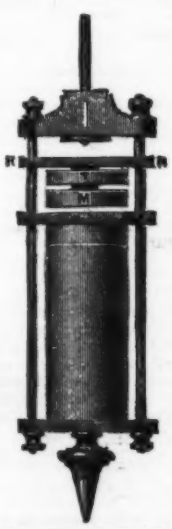
*Abstract of a paper read at the Buffalo Meeting of the American Association for the Advancement of Science. Translated for the Author by H. Carrington, Boston, Ph.D.—*American Chemist.*

until the casein has separated in large masses, when it is filtered through a filter, previously dried and tared at 110° C. The serum is not only (as usual) boiled, but, in order to completely separate the albuminates, it is evaporated to one-fourth of its bulk. Any albuminates thus separated are added to the casein upon the filter, and the whole of it is washed with cold distilled water until the washings cease to be acid. The liquid portion is used to determine the sugar. The author prefers to determine casein and albumen together as "milk-albuminates," instead of estimating them separately.

These albuminates, together with the filter, are now transferred to the funnel-shaped vessel B, which is placed upon the flask A, previously weighed air-dry. The coagulum is first washed with a small quantity of alcohol, part of which runs into A, and to which about three-fourths of its volume of ether is added. The apparatus is then placed upon the water-bath and connected with the upright (reflux) condenser. The ether must be made to boil only very gently, lest it might rise into the funnel in too large a quantity and carry back with it some coagulum. The vapors of the ether are condensed in the upright condenser and fall back upon the coagulum, producing thereby an uninterrupted exhaustion. After some time a drop of the ether passing from the funnel B, is allowed to evaporate upon blotting paper, when a total disappearance of the stain indicates that all the fat has been extracted. The same condenser is now turned about its supporting pivot D, so as to lie in an inclined position, A is connected with it, and the ether and alcohol contained in it are recovered by distillation. The residue in the flask, dried at 105°–110° C., represents the fat; the remainder of the coagulum, dried at the same temperature, the casein and albumen.—*Ber. d. Deutsch. Chem. Ges.*

IMPROVED PENDULUM.

IT is a well known fact that the action of pendulums is affected by variations in the pressure of the atmosphere, and various arrangements have been devised with a view to remedy this. The annexed figure represents one which has recently been described to the Paris Academy by M. Redier. The pendulum, it will be seen, is one of those with a mercury compensator. R R is a fixed support, to the middle of which is attached an aneroid barometric case, T. A mass, M, attached to this case, has a compensating action. When the atmospheric pressure increases, the case T is pressed in, and the mass M being thus brought nearer the point of suspension, the pendulum is accelerated, thus compensating the retardation which arises from increase of pressure. The opposite effect occurs when the pressure diminishes. In this arrangement the effect can be easily calculated,



IMPROVED PENDULUM.

and as the value of the displacements of the case T is known, all that is necessary is to give the mass M a weight in proportion with the error to be corrected; a quite elementary calculation. "Without entering on the development of the calculation," says M. Redier, "I will give some idea of the security offered by this system. A hundredth of a millimeter in the length of a pendulum produces a variation of 0·6 s. This is nearly the variation to be corrected for average differences of pressure. The barometric case is displaced 0·30 of a millimeter for these differences. If I attached the bob itself to the case T, I should then have 30 times more compensation than would be necessary. It is sufficient, therefore, that I attach to my case a mass M, which is the thirtieth of the weight of the bob, to obtain the effect sought. I indicate here merely rough data; the weight depending on its position with reference to the bob. Those who know the theory of the runner of Huyghens will comprehend the importance of this position.

THE PHYSIOLOGICAL ACTION OF LIGHT.*

By PROFESSOR JAMES DEWAR, M.A.

New Method of Experimenting.—One of the chief difficulties in arriving at the exact relation between the electrical variation and the luminous and color intensity of light was the continually diminishing sensibility to the stimulus, owing to the abnormal conditions of the eye when removed from the head. When the experiment begins, the eye is remarkably sensitive to light, and a large variation of current is obtained; but the amount of this current is gradually falling, in consequence of the gradual change in the parts of the eye, owing to their loss of vitality and sensibility. In fact, the parts are dying—the blood is not circulating, and molecular and chemical changes are slowly occurring. In the case of the frog, however, it is a fact that the retina retains its sensibility from three to four hours, and sometimes longer. After a lapse of two hours the frog's eye frequently remains in a tolerably stable condition, in which it does not lose sensibility rapidly. This condition may last for four or five hours. In order to get rid of the difficulty of gradual death of the parts, various methods were tried in earlier experiments in the attempt to remove the eye as quickly as possible, and to make the observations rapidly. In the case of the warm-blooded animals this did not lead to good results, because the sensibility to light disappeared in a very few minutes. On several occasions the posterior aspect of the eye was exposed in the living anæsthetized warm-blooded animal, and on bringing one electrode into contact with the severed optic nerve while the other touched the cornea, the observations were tolerably constant. This method was troublesome and difficult.

These experiments are now made in a different way. By placing a frog, rabbit, or pigeon under the influence of chinoline, the animal remains motionless. A small portion of the surface of the cranium is then removed so as to expose a portion of the brain. One of the electrodes is brought into contact with the surface of the cornea, and the other

Diagram showing arrangement of apparatus in the experiment on eye of frog. A, Eye showing the electrode, E, in contact with it. B, Skin removed, and subcutaneous tissue in contact with other electrode, E. K, Key. G, Galvanometer. Arrows indicate direction of current. Cornea, positive. Back, negative.

with the surface of the brain. The blood is still circulating. A current is obtained; and all the effects I have just mentioned may be observed with ease. The animal remains in this condition, retaining its sensibility to the action of light, for as long a period, in the case of the frog, as forty-eight hours. These observations led to the discovery, made recently, that there is no necessity for even exposing the surface of the brain. That is to say, the action of light can be traced, if needful, through the whole body. If, for example, we take a frog, place it in position, slightly abrade the skin on the surface of the head or back, or any part of the body, then adjust the electrodes, one in front of the cornea and the other upon the abraded skin, we obtain an electrical current which is affected by light in the usual way. But if the electrode in contact with the cornea be shifted to some other part of the body, a current may be obtained; but this current is not sensitive to light. In order to produce the specific action of light upon the eye, the retina must be included in the circuit. This discovery enabled us to perform many experiments without injuring the animal, except to the extent of abrading or removing a small portion of skin. It at once opened up the way for making observations upon warm-blooded animals (one of the chief difficulties in our earlier investigations). For example: give a rabbit or a guinea-pig a small dose of chinoline, and the animal remains prostrate and quiet. Then cut off a little of the hair from the surface of the head at the back of the neck, and abrade the skin so as to have a moist surface; bring the electrodes into position, placing one in contact with the abraded surface, and the other in contact with the surface of the cornea, and you will at once obtain the effect.

Action of Light in Warm-blooded same as in Cold-blooded Animals.—By the use of chinoline we were able to make experiments of the kind just described for a considerable time, without the necessity of maintaining artificial respiration. The result of those investigations upon warm-blooded animals has been to show that in these, as in the cold-blooded, light produces first an *increase* in the electric current on impact; continued light usually causes the electrical current to diminish; and on the removal of light there is a second rise, as described in the case of the frog. In our earlier investigations, we always observed in the case of warm-blooded animals (when the eye had either been quite removed from the body or was receiving an inadequate supply of blood), that the action of light caused a negative variation, that is, a *diminution* in the electrical current. By improved methods, however, which have the effect of placing the eye in conditions more normal, we find that light causes a *positive* variation, that is, an increase; thus agreeing with what had hitherto been observed in the eye of the frog. This is a point worthy of notice. Du Bois-Reymond showed, even in the case of sensory nerves, that physiological action caused a *negative* variation. But it appears that in the case of the retina the action of the normal stimulus is to cause a positive, not a negative, variation.

Experiment with the Living Lobster.—The action of light can be readily shown in this animal. Fix it loosely in a cloth, and lay it on the table in a slightly oblique position. With a small trephine remove a circular portion of the carapace, about three millimeters in diameter, and expose the moist tegumentary surface. Bring one electrode into contact with this surface, while the other touches the cornea. The usual effects of light may then be noted; but, in the case of the lobster, the variation caused by the impact is greater than what we have noticed in any other animal, often amounting to one tenth of the total amount of current. Another interesting experiment, comparable with that of the two eyes just described, may be made on the lobster by placing an electrode in contact with each cornea. The result frequently is apparently no current, but in reality the currents neutralize each other. Light falling on the one eye causes the needle to move, say to the left, while, if it fall on the other eye, the needle swerves to the right. When the eye of the lobster, removed from the body, was divided longitudinally into segments, each segment was found sensitive to light. The effect of light was then to increase the primary current, but no inductive action was observed on withdrawal. This observation is interesting as a confirmation of the views of physiologists regarding the mode of action of a compound eye.

Mode of Experiment on Eye of Fish.—An experiment upon the eye of a fish may be made, in a very simple way, by a method adopted in Professor Stricker's laboratory in Vienna. Take a fish and give it a very small dose of woorara. It soon becomes almost motionless, and sinks in some cases to the bottom of the vessel. The animal would soon die in consequence of paralysis of the movement of the gills necessary for respiration. But, if we take the animal out of the water, put it upon a glass plate, introduce a little bit of cork under each gill, and then, by means of an india rubber tube placed in the mouth, allow a little water to flow over the gills, the fish will live out of water for many hours. By this method may be made the experiment upon the eye of a fish with like results.

Observation on Human Eye.—Having succeeded in detecting the action of light on the retina of the living warm-blooded animal without any operative procedures, it appeared possible to apply a similar method to the eye of man. For this purpose, a small trough of clay or paraffin was constructed round the margin of the orbit, so as to contain a quantity of dilute salt solution, when the body was placed horizontally and the head properly secured. Into this solution the terminal of a non-polarizable electrode was introduced, and in order to complete the circuit the other electrode was connected with a large gutta-percha trough containing salt solution, into which one of the hands was inserted. By a laborious process of education it is possible to diminish largely the electrical variation due to the involuntary movements of the eye-ball, and, by fixing the eye on one point with concentrated attention, another observer, watching the galvanometer and altering the intensity of the light, can detect an electrical variation similar to what is seen in other animals. This method, however, is too exhausting and uncertain to permit of quantitative observations being made.

Explanation of Variation in Direction of Current.—One phenomenon particularly attracted the attention of physiologists, and especially of those who first saw the experiments, viz., that sometimes, in the case of the eye of the frog, light produced an increase in the electrical current, and in other cases a diminution. This we could not at first account for. But we have been able to make out that the positive and negative variation, or the increase or diminution of the natural current on the action of light, depends upon the direction of the primary current, when the cornea and brain are in circuit. If the cornea be positive and the brain be negative, then light produces an *increase* of the electrical current. If, on the other hand, the cornea be negative and the brain positive, light then produces a *diminution* in the electrical current. It is thus conclusively shown that the current superadded, or if we may use the language, induced by the action of light, is always in the same direction; only in the one case it is added to, and in the other subtracted from, the primary current.

The Use of Equal and Opposite Currents.—Many experiments were performed in which equal and opposite currents

Diagram showing arrangement of apparatus in experiment on living lobster. A, Corneal surface, having electrode, E, in contact with it. B, Portion of carapace removed so as to expose moist surface for electrode, E. K, Key. G, Galvanometer. Arrows indicate direction of current.

were transmitted through the galvanometer at the same time. By the use of resistance coils, it was not difficult to balance the current from the eye; but, owing to the inconsistency of even a Daniell's cell in such experiments as these, it was impossible to avoid fluctuations which might possibly have been mistaken for those due to the action of light. This difficulty was got over by what was formerly called *the double eye experiment*, in which two similar eyes are placed in reversed positions on the electrodes, so that the current from the one neutralized that of the other. When this is accomplished, it is easy, by means of a blackened box having a shutter at each side, to allow light to fall on either the one eye or the other, and it is then shown that the galvanometer needle moves either to the right or left, according to the eye affected. Instead of removing the eyes from the head and balancing them as just described, it is a much better method to apply the two electrodes directly to the corneas in their natural position. By a little manipulation, it is possible to obtain two positions that seemingly give no electrical current. In these circumstances, light, allowed to fall on the one eye or the other, produces the effects above detailed.

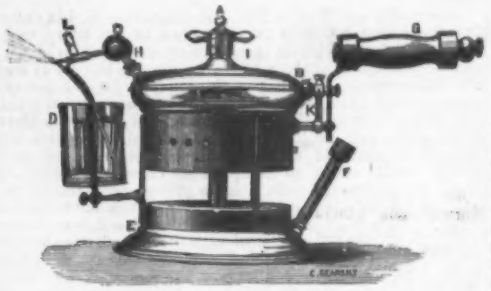
Action of Polarized Light and Colors of Spectrum.—The next point investigated was the action of polarized light and the various complementary colors. Early experiments, by passing light through solutions having various absorptive powers and by the direct colored rays of the spectrum, etc., lead always to the same conclusion—namely, that the most luminous rays produce the greatest effect. For studying the action of polarized light, the simple contrivance of a black box, having a hole on one side of it, placed over the eye, may be employed. Opposite the hole two cylindrical tubes of brass, each carrying a Nicol's prism, were placed, and between the two prisms a thin plate of quartz is introduced, producing the various colors of polarized light on rotating one of the prisms. The general results were exactly the same as with the colors of the spectrum. In all cases, the impact of the yellow rays produced the greatest effect. It has also been ascertained by this method that the effect of the *impact* of light is much more regular than the effect of its removal.

* Lecture at the Royal Institution, London.

NEW APPARATUS FOR ANTISEPTIC SURGERY.

By LUIS F. SAAS, M.D., New York.

IN order to meet the want, already beginning to be felt, of a self-acting, safe instrument, for the production of the antiseptic spray, one which could be readily obtained at a moderate cost, and would fulfill every requirement, I have devised the apparatus represented in the annexed woodcut, and which is being manufactured by Messrs. Ford & Co., of this city. I proceed to describe it: It consists simply of a copper boiler, seven and a half inches in diameter and two and a half inches in depth, securely connected to the frame of a spirit-lamp; the former being provided with suitable tubes for the atomization, by high steam-pressure, of the antiseptic solution. The whole instrument when connected measures eight and a half inches in diameter and eight inches in height.



The letter B in the engraving represents the copper boiler, which is filled with water, and where the steam is generated. A, safety-valve for the relief of boiler. This valve works with great nicety, and renders the apparatus perfectly safe from explosion. By rotating it at I, it can be detached and the boiler filled. H, C, L, atomizing-tubes with screw-valve (C) for regulating the volume and force of the spray, and small handle (L) for rotating the tubes upward or downward as far as required. The steam-tube is made of brass; the one through which the solution raises, of silver, with a lining of platina, so that other solutions besides carbolized ones can be employed without chemical decomposition. Both tubes are adjusted so that there can be no dropping from them. D, glass receiver for the antiseptic or medicated solution. E, copper alcohol-lamp with one burner, provided with a flame-regulator. Between the boiler (B), and the lamp (E), there is a perforated metal band, which serves as a flame-protector, and securely holds the boiler, being firmly attached to the lamp by the perpendicular bars shown in the figure. The boiler, flame-protector, and lamp are so securely connected that it would be impossible for them to become detached from one another through accident. F, metal funnel, by means of which the lamp can be refilled while the apparatus is working. G, wooden handle to hold the apparatus. K, glass water-gauge, to indicate the amount of water in the boiler.

To use the apparatus, the safety-valve is detached at I, by rotating it slightly, the boiler supplied with warm or hot water until the liquid is seen to reach the top of the glass gauge (K), and the lamp lighted. In a very few minutes the spray will be thrown from the atomizing-tubes, and its force and volume once regulated by the screw C, and its direction fixed upon the desired spot by the small handle L, the instrument requires no further attention. The spray can be thrown a distance of six feet, or more if desired, and will continue to be produced from two and a half to three hours without refilling the boiler; the only thing needed, even in protracted operations, being, to replenish the spirit-lamp, or the glass cup which holds the solution, as the case may be. These are both easily accomplished, and entail no interruption.

Besides the ease of manipulation, and the length of time the instrument can be operated, it is also readily adapted to all the uses sprays can be made to serve, as for inhalations in pulmonary and throat affections; spray-baths in skin-diseases; disinfection of apartments in cases of contagious diseases; production of a moist atmosphere in cases of membranous laryngitis, etc.

Finally, the component parts of the apparatus are easily separated, and the instrument can be readily packed for transportation in a box which is neither heavy nor cumbersome.

At the present time, when Lister's method of operating is attracting such universal attention, I have labored to devise an instrument for carrying out the antiseptic principle, which can be readily manufactured at a small cost here, in our own city, in which, simple in its details and perfect in its working, will be found durable and portable, and presenting also the advantage of ready adaptability to other uses than those for which it is principally intended. If it should prove as useful and reliable an instrument as I have designed it to be, and should meet the growing needs of the surgeon in this direction, I shall feel amply rewarded for my labors toward contributing what I feel to be a necessity for properly carrying out the antiseptic principle in surgery.—*New York Medical Journal.*

A PAPER ON MEDICATED ICE.

By J. VARNUM MOTT, M.D., Member of the New York County Medical Society; Member of the Medical Journal Association; Late Assistant Surgeon to the Metropolitan Throat Hospital; Physician to the Dispensary of the Church of the Holy Trinity, etc., etc.

MY attention was called, by an article in the *Medical Record* last fall, to this very important method of giving medicine, and I determined to give it a fair trial in all cases where it was impossible for the patient to swallow any liquid, owing either to inflammation of the pharynx or to nervous irritability. For instance, in the case of a child, where it is impossible to make any direct application to the throat without causing violent spasms, thereby reducing the nervous vitality, which is so important to sustain under all circumstances. Ice in small quantities is recommended by the highest authorities in the treatment of all febrile diseases. Patients, especially children, will continually ask for it, knowing that it has a very cooling effect upon the mucous membrane of the mouth, and its natural tendency is to reduce the temperature. Now, if it is beneficial in the normal state as a refrigerant, why not make its action of still greater value by the process of medicating it? I have devoted considerable time this winter in experimenting with Medicated Ice, so as to determine what drugs can most advantageously be used in this particular form.

In deciding this important point, two things must be considered: first, will your solution freeze naturally, or will the different ingredients separate? Second, can you obtain medicated ice that will be almost tasteless, and still retain its tonic or astringent properties? My answer to the first is *yes*, if you do not employ any oleaginous substance. I would also say yes to the second question, for it has been very thoroughly tested by me. As a general rule liquids, when frozen, lose to a very great extent the taste, either salty or bitter, which, in their normal state, is characteristic of them. Take a strong solution of chlorate of potasse, the taste is very decided; subject it to freezing, and you would hardly appreciate any flavor, and yet I am confident that its astringent properties remain unchanged. We all know how disagreeable it is to inhale carbolic acid, yet, when a mild solution is frozen, it is almost impossible to detect any unpleasant odor; it is almost tasteless, and performs its duties as a disinfectant with as beneficial results as in its original state. I have succeeded in reducing to this form almost every article that can be used to advantage in cases where deglutition is impossible, or where it is attended with great pain. Tonics and stimulants occupy a very important place in the treatment of throat diseases; in the form of medicated ice it is always acceptable and has proved very efficacious. Brandy, whiskey, and gin can be used according to indications. Laxatives are very much needed in these cases, and can readily be supplied by freezing a solution of the Citrate of Magnesia. Anodynes and nervines are very essential, both can readily be given, either a solution of acetate morphia or bromide potassæ reduce to the freezing point. I will now describe my mode of preparing the medicated ice: Having made your solution to the desired strength, place it in a large thin glass tube, filling it full, and placing a tight-fitting cork (rubber is best), so as to exclude all the air; then have a small tin or wooden pail filled with chopped ice, with a suitable quantity of salt, and place the tube in the ice, having turned it around for fifteen or twenty minutes, you have a solid mass of medicated ice occupying the tube, which is easily removed by the application of a warm cloth. Care must be taken that the tube is as large, if not larger, at the top than at the bottom, otherwise much of the solution will be lost before you are able to take the ice out. The physician should always prepare it for the first few times, or until he instructs the nurse or attendants exactly how it is to be done. I generally fill the tubes myself, and place them in the ice, for then I feel confident that no mistake is likely to occur, and they are ready for use at any time. Much has been written upon the action of cold on the stomach, and, before going any further, I desire to state that I have treated ten cases of throat diseases entirely by the medicated ice, until such time as the patients could swallow without difficulty, and in only one of them did I have any unfavorable gastric symptoms, which I found, upon investigation, was due entirely to carelessness on the part of the nurse, who neglected to follow my instructions. The case yielded, however, very readily to treatment, the application of a cataplasm and a warm stimulating enemata being all that was necessary. Excessive cold is very apt to produce or aggravate constipation, and it is but natural that it should, owing to the torpid condition of the muscles of the stomach and intestines; it is therefore an important point to watch and guard against as much as possible. I have found that it would generally yield to a mild laxative treatment. The important question naturally arises, how often shall the patient be allowed this medicated ice? This is a question that I shall not attempt to answer, for I feel that it is for the physician to decide in each individual case; circumstances may alter the treatment in any given case. One patient might take large quantities with impunity, whilst it would not be judicious for another to take it twice a day. The effect it produces upon the mucous membrane of the stomach differs very materially in each case; especially is it marked when a powerful astringent is used continually. In order to guard against any unpleasant effects, I generally change from one drug to another: for instance, I give an astringent, then a tonic, and finally a nervine, repeating this order as often during the day as I deem best; by these means I relieve the mucous membrane of any substance that, if too long continued, might irritate or inflame it. When the liquid assumes any color but white, when frozen, care must be taken, if the patient is a child, that he should not see the ice, for he would probably refuse to take it. I was obliged to change the treatment in a highly interesting case where I was using Monsel's Solution of Iron, in the frozen form, simply because the boy (aged 4 years) was permitted to see the ice. After that we could not persuade him even to take the clear ice. We all know how necessary it is to procure the very best hygienic influences for our patients, and we are equally aware of its very great and valuable assistance in the treatment of diseases of the throat; this point should be carefully looked after if we wish to obtain a speedy cure. Different apparatus are continually being introduced for the successful treatment of these diseases, but of how much value are they when the patient is unable to open the mouth far enough to admit of their application? Now, how easy it is both for the physician and patient to employ the medicated ice. There is not the slightest effort on the part of the patient required; the increased temperature of the mouth rapidly melts the ice, and the liquid passes slowly into the pharynx, coming into contact with the parts most affected, and quietly exerts a beneficial result. The class of cases where I have employed this method of treatment were in the best hygienic atmosphere, and all the surroundings tended to assist me in my efforts to relieve them in this manner. I have not the least doubt but that the treatment, if carried out in general practice, would afford great relief, at least, if not be the means of affecting a speedy cure by itself. I have treated four children with Diphtheria, between the ages of two and five years; three with Quinsy, one of them having it on both sides at once; two with acute Pharangitis; and one with acute tonsilitis. The act of deglutition in each of the above cases was almost impossible, and the action of the medicated ice was to me a source of great pleasure, for the effect was so prompt and effectual. In cases of Scarlet Fever it might be used with good results, for we generally have an inflamed condition of the pharynx associated with this disease from the beginning, and often it becomes very much aggravated towards the latter stages. If medicated ice was employed at once as an astringent, and then as a tonic, the natural tendency would be to reduce the inflammation, and control in a larger measure the febrile symptoms. We might, I think, very properly employ it in the treatment of almost all fevers, being governed in every case by the indications as they present themselves, and by that means we could change the composition of the ice as often as necessary; and in all probability we would find it a very valuable agent in reducing the temperature. We are often obliged to use medicines in the form of emulsions, and generally have to employ a vehicle, which, in either case, is apt to contain more fluid than we really care to give, but are obliged to do so in order to dissolve certain drugs, or to make them more palatable; reduce your solution to the form of ice, and you take away, to a very great extent, the taste, and save a superfluous quantity of liquid. In the treatment of croup I have known small pieces of clear ice to relieve the severe paroxysms of coughing to a very great extent; and it is my intention to employ it in the form of an emetic at my first opportunity; and, after emesis has thoroughly been established, to change the composition of the ice to an anodyne. The same might be said in cases of Whooping Cough, but of course we would employ those drugs which experience has taught us are most beneficial in combating this rather formidable malady. There are, undoubtedly, many uses yet unknown to which the medicated ice can be applied; and I have no doubt but that numerous diseases will soon be presented to our notice in which this agreeable form of administering medicines can be rendered of very great value to the medical practitioner. I append a few preparations which in my hands have proved very satisfactory, administered in the frozen form. I trust that others will test this method of treating severe cases of throat disease, and that they will give us the benefit of their experience:

Laxative.

℞ Citrate Magnesia ..... ʒ iv.
Sig.—Freeze. Give in small pieces.

Astringents.

℞ Potassæ Chloras..... ʒ ij.
Tr. Ferri Chloridi ..... ʒ j.
♏ Aquæ..... ʒ iv.
Sig.—Freeze, etc.

℞ Liq. Ferri for Sulphatis..... gtt. *xxx.*
♏ Aquæ..... ʒ ij.
Sig.—Freeze, etc.

Tonics.

℞ Valentine's Beef Juice ..... ʒ i.
♏ Aquæ..... ʒ j.
Sig.—Freeze, etc.

℞ Quinnæ Sulph ..... gr. iv.
Acidi Sulph. Aromat ..... q.s.
♏ Aquæ ..... ʒ iv.
Sig.—Freeze, etc.

Disinfectant.

℞ Acidi Carbolici. ..... gtt×.
♏ Aquæ..... ʒ iv.
Sig.—Freeze, etc.

Anodynes.

℞ Potassæ Bromidi ..... ʒ ij.
Aquæ ..... ʒ iv.
Sig.—Add water, and freeze.

℞ Morphiæ Acetat..... gr. i.
♏ Aquæ..... ʒ iv.
Sig.—Freeze one ounce at a time.

Stimulants.

℞ Spiritus Vini Gallici..... ♏ ss.
♏ Aquæ..... ad ʒ ij.
Sig.—Freeze, etc.

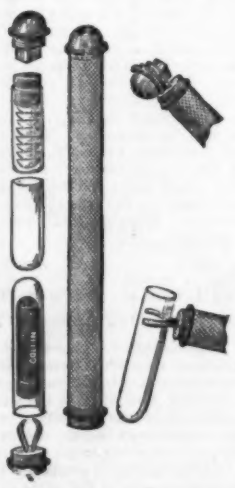
℞ Spiritus Fermenti ..... ♏ ss.
♏ Aquæ ..... ad ʒ iv.
Sig.—Freeze, etc.

I might enumerate many other drugs that can be exhibited in this form, but will refrain from doing so at present. The formulæ above are full strength, and must be changed according to the age of the child. The addition of sugar, in some cases, might be of service. The formulas can be divided to suit the case into as many doses as necessary by the addition of water or some fluid extract.

No. 99 Park Avenue, New York, May, 1877.

A POCKET-CASE UROSCOPE.

MR. YVON describes in the *Répertoire de Pharmacie* (1877-8) a new apparatus for the examination of urine, which does not take up more room than an ordinary caustic-holder, and may be carried about in the pocket-case. The annexed cut explains the arrangement. A metallic tube is divided into two compartments and closed at each end by a screw-



stopper. The smaller compartment contains a test-tube for heating urine; within this tube is a small gutta-percha case or tube filled with blue or red litmus paper. The stopper fitted to this compartment has an outer and an inner thread, and bears a clamp in its centre, which is pointed inside when the instrument is closed, but is reversed when using it, to form a test-tube holder. The second compartment contains a spare test-tube, and another tube closed with a rubber stopper, and containing pieces of caustic potassa.

The metallic stopper of this second compartment contains a small microscope of sufficient power to examine urinary deposits. This instrument is intended to be inserted into the clamp of the other stopper when using it. The practitioner will be enabled by means of this arrangement to examine the alkalinity or acidity of the urine, to search for albumen, or for sugar (by means of the pottassa), and to examine the urinary deposits.

THE CARE OF THE EYES.

BEING QUESTIONS SUBMITTED TO

E. G. LORING, JR., M.D.,

BY THE NEW YORK MEDICO-LEGAL SOCIETY.*

First question.—"Whether bad air has any direct effect on the sight, or only mediate or resultant from other immediate bad effects?"

In considering this question, I shall first assume that the real meaning of the question is whether bad air has a direct effect upon the organ of vision, and not simply as to its perceptive power, which the word *sight* taken literally would imply. I shall then consider the question as it actually reads, that is, as affecting the perceptive power.

I have no doubt in my own mind, and I believe it is universally admitted, that vitiated air has a direct irritating effect on all mucous membranes, and I feel convinced from my own observation that the mucous membrane of the eye is peculiarly susceptible to its influence. This is shown by the fact that repeated attacks of inflammation of the mucous membrane of the eye, which have occurred in a vitiated atmosphere, and which have resisted all curative means, are often cured at once, and prevented from recurring, when a wholesome supply of air is obtained, all other conditions remaining the same.

I am therefore of the opinion that bad air alone, acting as the primal cause, may set in train a series of morbid processes, which may, and often do affect, not only the working capacity and integrity of the organ, but which may lead even to its total destruction. Thus, simple irritation of the mucous membrane of the eye may, and often does, pass into actual inflammation, which, increasing in violence, may proceed from part to part till the entire organ is involved, and thus the sight become impaired or totally lost.

That bad air, in the ordinary sense of the word, and excluding irritating gases, has a *direct* effect on the sight—that is, on the amount of perceptive power—I do not believe, nor do I understand this to be the question submitted to me; but that an impairment or loss of vision may be attributed to bad air as a direct result follows, I think, from what has been stated above.

Second question.—"Whether size and quality of type may cause disease of the eye?"

First, in regard to size of type. The smaller an object is, the nearer it has to be brought to the eye to be perceived.

It has been accepted by oculists that type embraced by an angle equal to 5′ (five minutes) is the smallest printed matter which can be recognized by the average normal eye. According to this formula, the smallest print which a normal eye can readily recognize at a distance of one foot is about $\frac{1}{200}$ of an inch; at eighteen inches (the average distance at which the book is held by an adult), the smallest recognizable type would be about $\frac{1}{300}$ of an inch. The normal eye should never be subjected for any length of time to a type smaller than twice this size, that is, $\frac{1}{150}$ ($\frac{1}{75}$) of an inch, and it would be better after middle life to employ a type even a little larger than this. The fact, however, that spectacles are now so commonly used removes in a great degree, by restoring to the eye its former focalizing power, the necessity of a larger type with advancing years. Young children should never hold the book nearer to the eye than ten inches, and adults never further from the eye than eighteen inches. As soon as perfectly distinct vision at this distance cannot be obtained, and if obtained, cannot be easily maintained, recourse should be had to spectacles.

The finer, then, the type, the closer the book has to be brought to the eye, and the greater the tension or demand on the focalizing power, and the muscles which are used in bringing both eyes to bear at the same time upon the object viewed. These two acts make what is called the act of accommodation of the eye, and tension of the accommodation, that is, long-continued use of the eye upon objects brought close to it, is considered by all authorities one of the most, if not *the* most, fertile causes of progressive near-sightedness.

This condition may be accompanied by morbid processes, which may involve the deeper-seated membrane of the eye to such a degree as to not only affect the vision but to even destroy it. Too fine print, therefore, may be, I think, looked upon as a factor in producing eye disease, affecting not only the external but also the internal parts of the organ.

On the other hand, too course print is wearisome to the eye, as it requires more exertion of the muscles governing the movements of the eye, that is, for a given amount of matter; and especially is this the case when the breadth of the page is, as usually happens, increased so as to keep the just proportion of matter on a line. This leads me to observe that usually the breadth of the page is, if anything, too great. This causes undue exertion on the part of the muscles which move the eye in a lateral direction, and is apt to lead to confusion in finding the next succeeding line. It is for this reason that the narrow form of English blank verse is so little fatiguing to the eye.

The popular prejudice in regard to the double column on a page would be untenable were it not that the same economy which restricts the amount of space also reduces the size of the type and crowds the lines together. A double column page which is well printed and properly divided is certainly preferable to the same amount of matter extending in a single line across the entire page.

The distance between the lines, that is, from the bottom of one line to the top of the other, should be about $\frac{1}{17}$, or one eighth of an inch. Nearer than this is apt to be confusing; further, fatiguing.

The distance, however, can be considerably less in a page with a double column than in one with a single.

If a double column page is used the distance between the columns should not be less than one quarter of an inch.

Quality of Type.—The less contrast there is between an object and its surroundings the more difficult it is to see the object, and the closer it has to be brought to the eye. A faintly printed page has therefore to be brought nearer, oftentimes very much nearer, than a well printed page of the same type. There is nothing more wearisome to an eye than an indistinct and blurred image of a familiar object, and no more striking example of this could be found than blurred or faintly printed type. This should be sharply cut, and what is technically called "heavy faced," in contradistinction to "light faced" type. Of the former, a common example is the English; of the latter, the American.

The ink is also a matter of importance.

English ink, like the type, is vastly superior to American. The color and quality of the paper has also an influence upon the ease with which the act of vision is performed. For, while it is true that there should be as much contrast as possible between the type and its surroundings, care should be taken to avoid all glare or dazzling of the page. Pure white paper, such as is ordinarily used in this country, should not be employed, most of all when it has, as it often does in the cheaper papers, a metallic luster with a bluish tinge. I have come to the conclusion that, as a rule, a very light, almost imperceptible, yellow tint is the best. This is known in the trade as "natural" tint, from the fact that it contains no dye whatever, and has been bleached only to a moderate degree. It has the color of unbleached cotton cloth. It is, however, expensive, as it can only be made from the best stock; still a very good imitation can be had in some of the second-class papers at a moderate cost. The paper should be thick enough not to be transparent, should have a close, fine texture, and be free from sponginess.

From these facts, I am of the opinion that, both in respect to size and quality, imperfect type may be considered as a factor in the production of eye diseases.

Third question.—"Whether too long and constrained attention to one object without rest or variety will cause eye disease?"

That prolonged tension of the eyes may be the primal cause of a great number of diseases of the eye is admitted by all authorities, and the more fixed the gaze, and the narrower the field of view, the greater the danger. If it be true that continued tension of muscular and nervous force unduly exhausts the energy of any organ, it is doubly true of the eye. The nervous energy of the retina, sensitive and rapid as it is, is just as rapidly exhausted, and the act of reading would be unbearable after a few moments, if the eye did not quickly change its position from letter to letter, and from line to line. Diversity of action is as much a necessity in the case of the eye as of any other organ for an easy and lasting performance of its function. No eyes, in my opinion, should be used more than an hour at the furthest in the act of reading or writing without an interruption of the gaze, and it would be better if several, if not many, interruptions should take place in the same time.

This usually happens in the case of adults for some reason or other; but children, in order to complete their tasks in an allotted time, are often compelled to use their eyes, without sufficient interruption, by the hour together. It would be impossible, and out of keeping with the condensed character of these remarks, to enumerate here all the diseases which may arise from prolonged tension of the eyes on near work; but there is an affection produced by it which is so frequent in its occurrence, and so unfortunate in its results, that I cannot refrain from saying a word in regard to it, using substantially the language of one who is the greatest authority on the subject instead of my own. Professor Donders thus remarks:

"The distribution of near-sightedness chiefly in the cultivated ranks points directly to its principal cause: tension of the eyes for near objects. Respecting this fact there can be no doubt.

"Three factors may here come under observation:

"1st, pressure of the muscles on the eyeball in strong convergence of the visual axes; 2d, increased pressure of the fluids resulting from accumulation of blood in the eyes in the stooping position; 3, congestive processes in the eye which, tending to softening, give rise to extension of the membranes. Now, in connection with the causes mentioned, the injurious effect of fine work is by imperfect illumination still more increased.

"To this it is to be ascribed that in schools where, by bad light, the pupils read bad print, or write with pale ink, the foundation of near-sightedness is mainly laid, which, in fact, is usually developed in these years."

Fourth Question.—"Whether the angle at which the light strikes the eye is important, that is, ought it not to fall, not full in the face of the child, but first on the book, or work, and be reflected into the eye?"

Before answering this question precisely as it now stands, I should like to premise it by making the general assertion that not only is the direction in which the light comes important, but also its quantity and quality. Reduction in illumination is, as a rule, precisely equivalent to a reduction in the size of the object. Therefore, the less the light, the nearer an object has to be brought to the eye, and the greater the strain in the act of vision.

It is impossible to fix with any scientific exactness just the size that a window should be to give sufficient light for visual purposes, since this must vary with the exposure and surroundings of the room; but it has been reckoned in Germany that for a class room, containing twenty persons, there should be, at least, 4,000 to 6,000 square inches of glass, which would give to each scholar, from 200 to 300 square inches, or what would be represented by a pane of glass from 14 to 17 inches square. Such a room as this would be sufficiently lighted in any part. A room 20 feet square should not contain less than 70 to 80 square feet of glass, and it may be laid down as a rule that too much light cannot be obtained in a room, as all excess of glare can be guarded against by artificial shades if properly applied.

More light enters a room from the same amount of glass from the south than from the north, and a southern, southeastern, or southwestern exposure is better than a northern, northeastern, or northwestern, especially for class rooms, and this, too, simply in regard to the amount of light, and independent of the purifying influences of direct sunlight.

That a north room is better for the purposes of the artist is due to other causes, and does not affect the general rule.

The light should not come from directly in front, and especially is this the rule when artificial light is used. For when the light comes from directly in front of the person, the pupil of the eye becomes unduly contracted, which is equivalent to reducing the quantity of light, since less light enters the eye from the object viewed, while the eye is exposed to too much light reflected from the surrounding objects and from the direct rays from the source of illumination.

Neither should the light come from directly behind, as the object then lies in the shadow of the body. Nor yet from the right side, because, in writing, the shadow of the hand falls across the page, and a moving shadow over a lighted surface not only reduces the quantity of light and leads to a stooping position, but it is also more annoying to the eye than a uniform reduction in the illumination of even a greater degree.

The best direction for the light to come is from the left-hand side, and from rather above than below the level of the head. Windows, therefore, should not run down too near to the floor, as they often do in class rooms and offices.

I cannot agree with the opinion, often expressed, that the best direction for the light to come from is from directly above.

I cannot refrain from adding, in this connection, the conclusion, founded on Dr. Cohn's elaborate investigations in regard to the near-sightedness among school-children from Germany. He thus formulates it: "The narrower the street in which the school-house was built, the higher the opposite buildings, and the lower the story occupied by the class, the greater the number of near-sighted scholars."

I should then, from these considerations, say that the angle at which the light strikes the eye is important, and that it ought not to fall in the face of the child, but first on the book or work, and be reflected into the eye.

* Read before the New York Medico-Legal Society, Feb., 1877.

ANCIENT AND EXTINCT BRITISH QUADRUPEDS.

By A. LEITH ADAMS, M.D., F.R.S.

(Continued from SUPPLEMENT No. 72.)

The former existence of the Elk or Moose in the forests of ancient Britain has been inferred from several discoveries. On one occasion portions of its remains were found in the cave of Llandebie, in Wales, in proximity with remains of the Brown Bear. It is not probable, however, that the Elk was very plentiful in this country, although still not uncommon in Norway, and generally distributed over Canada; it is evident that no deer could have sojourned for ages in a country without leaving behind them traces of their former existence, not only in their cast antlers, but on account of the fact that they were much more numerous than the Carnivora which prey upon them.

The Fallow Deer, a native of Southern Europe, and still met with in several islands of the Mediterranean and elsewhere, has, on the discovery of a single horn in the mud of the Thames at Clacton, been supposed to have inhabited Great Britain in the days of the elephants, bears, and other animals of the post-glacial period.*

The Reindeer was one of the earliest arrivals on British soil after the ice and snow of the glacial epoch began to disappear. It must have been very common in England and Ireland, and perhaps also in Scotland—at all events, after the great glaciers began to recede. Remains of the animal have been discovered in thirty caverns and in as many river deposits throughout England, and in Irish caverns, and in shell marl under Irish bogs and Scottish lakes.† It is still plentifully distributed over the boreal regions of Europe, Asia, and America, but varies considerably in dimensions, and somewhat in the appearance of the antlers, in different countries; indeed, as regards height and weight, there are remarkable peculiarities in different regions. Thus the Reindeer of Lapland is small, as compared with the Siberian and Newfoundland forms; the former stands about three feet five inches, whilst the latter is on an average four feet two inches at the withers, their weights respectively being often 90 lbs. and 300 lbs. There is no evidence to show when the Reindeer disappeared from the British Isles, but it was contemporary with the Lion, Hyæna, and Elephant, and lingered on until the advent of man, whose flint tools have been discovered in the same deposits which contain its bones. The fossil remains, as compared with the bones of recent varieties, such as the Caribou or Great Woodland Reindeer of Canada and the smaller forms of Northern Europe, approach, in the rounded beam and large brow antler and dimensions of bones, to the Norwegian and Lapland Reindeers, which are probably direct descendants of the old British stock; so that the ancient Reindeer of Great Britain was not relatively so large as many individuals now living. The bones found in English caverns, and that of Shandon, in Ireland,‡ were fragmentary, and had evidently been dragged there by predaceous animals. There are, however, two splendid heads, almost entire, from the bog marls now in the museum of the Royal Dublin Society, one of which has been already referred to in connection with the discovery of the skulls and bones of the Giant Deer; the other, and more perfect of the two, is from a neighboring locality among the Dublin mountains.

As known to us at the present time, the Reindeer is associated with an Arctic climate. It is, however, still not uncommon in North America as far south as New Brunswick, and was even common lately in the forests of New England, latitude 40°. But doubtless the climate of our islands in former days was much colder than at present; indeed, the same may be said of Central Europe, inasmuch as Reindeer remains have been found in the caverns of the South of France.

There are no ruminating animals more given to extensive migration than many varieties of the living Reindeers of North America and Asia, so that their northern and southern limits frequently include many degrees of latitude. They are easily hunted down, and consequently soon exterminated from particular tracts.

The Red Deer, like the Roebuck, the Mole, and the Water Rat, is one of the few survivors of the extensive list of mammals which inhabited Great Britain during the Pliocene epoch—*i.e.*, the epoch which immediately preceded the glacial period. Their pedigrees, therefore, are as ancient as any in the land—at all events, so far as the discovery of fossil relics is concerned; but in all probability neither of the two first-named would have survived but for the protective influence of man.

Remains of the Red Deer are met with in peat and superficial soils; in clay and marl below the latter; in more ancient cavern deposits, associated with relics of nearly all the extinct and several living species, as well as in estuaries and river deposits, said to have been formed before the glacial epoch. The bones and horns of the more ancient individuals are, on an average, larger than our semi-domesticated races. Indeed, the denizens of Great Britain are inferior in size and development of horn to those of Northern and Central Europe; whilst the Red Deer of Siberia and the Himalayas are even larger still, and approach more nearly the largest fossil forms, and to the great Wapiti of Canada; so that, considering the antiquity and wide-spread distribution of the Red Deer, and the varying climates in which it exists, one might almost refer them all to one species, certain varieties of which have become differentiated under the influence of food, climate, and situation. Horns of the Red Deer from the same deposits in Ireland as those of the

* *Vide supra* p. 93.

† As many as 1,000 antlers are said to have been taken from a rock fissure in South Wales. Falconer, Palæontological Memoirs, vol. ii., p. 560.

‡ Shandon Cave, near Dungarvan, Co. Waterford, where bones of upwards of fifty individuals have been found associated with those of the Wild Horse, Mammoth, Red Deer, Wolf, Bear, and FOX.—ED.

Gigantic-horned Deer are not so massive as those of the same age from many localities in England and Scotland.

The Roebuck does not appear to have been a native of Ireland, according to the historian Giraldus Cambrensis, who seems to have been well acquainted with the beasts found in England in his day (1180), and at all events made inquiries in Ireland with reference to the wild animals of that country; but when its condition at that period is considered, the probability is that its fauna was comparatively unknown.

The Musk Ox, or Musk Sheep, as it is variously named, now confined to the Arctic Regions, was once a native of England, as testified by the discovery of its remains in eight or ten different localities, either in caverns or river deposits, associated here and there with remains of the Hairy Mammoth and the Hairy Rhinoceros.

The ancient British oxen were of two species, a Giant Ox and a Bison.

The Primæval or Giant Ox was a noble animal; but both species were gigantic in size, and were doubtless formidable antagonists to even the lions of the period. The Bison seems to have been prevalent in Great Britain during and long after the Roman invasion, whilst, on the other hand, there are evidences to imply that the one under consideration lived in the land before the glacial period.

The Primæval Ox's remains are met with in ancient tumuli, but perhaps it was exterminated before Cæsar's landing.*

In the brick earths of the Thames valley magnificent heads of this noble-looking animal have been discovered from time to time. Even the horn cores in many instances measure three feet, with a breadth of forehead between horns of one foot. Although abundant remains have turned up in England, Wales, and Scotland, there are no authentic data of the animal in connection with Ireland. Whether the semi-feral Chillingham breed belongs or not to this species, it is evident that it is, as regards size, a degenerate race of either of the British fossil oxen. As to the assertion that our domesticated cattle are descended from the Giant Ox, it may be stated that, unless introduced by the Romans, there is a probability that the Long-fronted Ox, which will be noticed presently, may have sprung from the latter, and in the course of ages become through domestication a distinct variety, from which all our modern cattle have been derived; but the foreign wild species are so numerous, that to speculate on domesticated breeds and their progenitors would be a fruitless undertaking. With reference to our islands, and Europe generally, it was believed by Cuvier—and Bell in his "British Quadrupeds" is of the same opinion—that our domestic cattle are the degenerate descendants of the Wild Ox; whilst Professor Owen is more inclined to think that the Romans were the first to introduce cattle into England. The discovery, however, of remains of the Long-fronted Ox in various parts of the country, associated with stone and bronze implements considered pre-Roman, gives strength to the view that it was reclaimed by the ancient Britons long before the invasion. It seems, however, now impossible to differentiate all the points in connection between the wild and tame oxen, so as to come to just conclusions as to their relationships; indeed, as far as pedigree is concerned, the British human and bovine animal are on a par.

The Bison or Aurochs seems, if anything, to have been more plentiful than the Giant Ox. It was larger than the living Bisons of Europe and America, but the connections between the three are very close, and, when we admit time as a factor, in conjuction with food, region, and climate, it may be fairly allowed that the present denizens of the Lithuanian, Moldavian, Wallachian, and Caucasian forests and Northwestern America are very closely allied to each other, and to the fossil remains found in Great Britian and on the Continent.† The finest bulls of the Lithuanian breed stand about five feet six inches at the withers, whilst, according to Richardson, the American Bison is upwards of six feet in height. The fossil British Aurochs, as compared with these, must have frequently reached a height of seven feet at the shoulder. The Grisly Bear is at present one of the most formidable enemies to the American Aurochs, as doubtless was also the case in bygone times on British soil.

The Long-fronted or Small Fossil Ox is considered by Prof. Owen to be an ancient and distinct species which sojourned with the other oxen, bears, elephants, and like extinct quadrupeds. It seems to have been very plentiful in Ireland, and survived at all events up to the human and most likely the historical period, in which cattle are frequently noticed in old Irish MSS.,‡ but of course not described with the necessary exactness to enable us to determine the species or breed. In bogs, and the deposits of lakes, especially in those of Loch Gur, its bones and skulls have been found in numbers. Many of the latter show fractured indentations on the forehead.*

The antiquity of the Long-fronted Ox has been lately disputed by Professor Boyd Dawkins, who is of opinion that this Ox and the Goat were brought to Great Britain from the Continent by man long after the larger animals had disappeared—some time in the period which intervened between the commencement of the formation of bogs on the ancient Irish lakes and the first historical evidence of the animals of the country. It is doubtful, however, whether or not we have sufficient evidence as to the exact antiquity of this Short-horned Ox. It would seem that remains have recently been found both in conjunction with the Bison and Giant Ox, Elephant, and Rhinoceros in England, and in lacustrine marls in Ireland, associated with bones of the Great-horned Deer. Looked on in connection with the origin of our cattle, it seems at all events, whether descended from the *Urus* or any other wild species, to have contributed towards the tamed stock; none of these, however, retain its well-marked cranial characteristics, which are conspicuously shown in the lengthened forehead. There are decidedly, however, so far as Ireland is concerned, very many variations in the curvature of the horns of skulls dug out of peat, which would seem to point to a long course of domestication; at all events, whether the animal was or was not a wild denizen of the land, it was very generally reared and eaten in England and Ireland during the early colonization of the islands.

Few facts in the natural history of the British Islands are more surprising than that elephants, rhinoceroses, and a species of hippopotamus once dwelt in our land, when its physical aspect was not materially different from what obtains at the present day. No doubt these and other extinct mammals were more plentiful when Great Britain formed part of the continent of Europe, and when the Thames and other rivers were broader, as testified by their deposits. Still there is evidence to show that they lingered on after Great Britain had become separated from the mainland, a few only surviving the prehistoric period.

The Thames valley in olden times, as shown by the animal remains found in its deposits—*i.e.*, remains of elephants, rhinoceroses, and river-horses deer oxen, and so forth—must have presented a wilder aspect than even the banks of the upper Nile at the present day.

Not many years ago, whilst some workmen were employed in deepening a cellar below a club in Charles Street, St. James', they discovered the grinding tooth of an Elephant, a portion of the back-bone of the Giant Ox, and the curved canine tooth of a Hippopotamus, all in the clay which underlies the gravel so well known to London geologists.

The Great Hippopotamus, which inhabited England before the glacial epoch, returned again at its close, along with other quadrupeds. It appears to have been not uncommon, seeing that remains have been found in bone caves in Devonshire, South Wales, Somersetshire, Huntingdonshire, Cambridgeshire, Bedfordshire, Gloucestershire, Middlesex, and Yorkshire, and in the deposits of the rivers Thames, Ouse, Cam, and Avon. There is only one record, and that not well authenticated, of its occurrence in Ireland, a canine tooth having been found near Carrickfergus, and in Scotland no traces have turned up.

In size and character the extinct river-horse of Northwestern Europe differed in some degree from the present denizen of the Nile, which even in historical times was plentiful in Egypt, where teeth of individuals have been discovered in river alluvium as large as those of many of the Great Hippopotamus. It may be that the former is a degenerate and modified descendant of the latter; and whilst we hesitate to associate in idea the naked hide of the Nile animal of the present day with our colder climate, enough is known of the Hairy Elephant and Rhinoceros, which dwelt here contemporaneously, to warrant the inference that the Hippopotamus may also have had a woolly coat.

Great Britain, or rather the area embraced by the insular group, during that epoch which preceded the glacial period—when, as has been already remarked, the aspect of the country, so far as its plains, rivers, mountains, and valleys were concerned, did not differ materially from what obtains at the present day—was tenanted by two species of elephants, one of which, the Southern Elephant, did not reappear on the scene after the glacial ice and snow had begun to yield to the coming temperate climate. The other species, named the Ancient Elephant, returned to its old haunts, and the Mammoth Elephant appears now on the scene for the first time. At all events, so far as has been ascertained, there are no indications of the latter having arrived beforehand, as none of its remains have been discovered in deposits anterior to those of the glacial period.

The discovery of an entire Mammoth in the flesh, at the commencement of the present century, in frozen soil at the mouth of the River Lena, and the subsequent removal of the carcase to St. Petersburg, where it now remains, show that, like the Hairy Rhinoceros hereafter mentioned, it was an animal adapted for a cold climate.

The Mammoth at the period under consideration, and up to a late geological date, had an almost world-wide distribution. Its tusks are found in such quantities along the Siberian shores and islands to Behring's Straits, that a thriving trade in ivory has resulted, whilst the fishermen on the coast of Norfolk have dredged up many thousand grinders and tusks of the animal. It has left its remains in North America as far south as Mexico, and in Europe from the frozen seas to Rome. In Great Britain it has been traced throughout England, Wales, and the south of Scotland, and remains have been found in two widely distant localities in Ireland.*

In fact, of all the ancient British mammals the Mammoth was evidently one of the most common, and seems to have survived the Elephant, next to be mentioned. Of its contemporaneous existence with man in Europe, we have evidence not only in the discovery of stone implements along with its remains, but a few years since a fragment of the tusk of a Mammoth was found in the cave of La Madelaine in the Dordogne, on which was a rude but faithful representation of this Hairy Elephant, etched by means of the stone implement of some cave dweller of the period, when, together with the Reindeer and the Bear, it roamed over Southern France.

The Ancient Elephant, as it has been named, was, as far as our islands are concerned, not so gigantic in stature as the Mammoth, and was distinguished by the possession of grinders formed on a very different pattern. Taken in conjunction with other differences in the skeleton, these characters afford as well marked distinctions between it and the Mammoth as those which exist between the African and Asiatic Elephants. The Ancient Elephant has been more frequently found in middle and Southern Europe than in the northwest; nevertheless, from the quantities of teeth and bones found in England, the probability is that the Elephant was at one time quite common here.

In regard to geographical distribution, the exuviæ hitherto discovered show that it was confined to Europe. The tusks of the Mammoth curved considerably upwards, whilst those of the Ancient Elephant much resembled the tusks of living species, and were nearly straight. In point of size, neither of the fossil species very much exceeded the largest African Elephant, although the bull Mammoth, as a rule, was considerably taller than its living representative.

Admitting points of distinction between these two extinct elephantine animals, we are naturally led to inquire how far they differed from the Asiatic and African Elephants of the present day. It may be stated generally that in its skeleton the Mammoth is closely allied to the Asiatic Elephant; so alike are they, indeed, that, but for the peculiar construction of the grinders and the curling tusks of the Mammoth, it would be difficult to distinguish them.

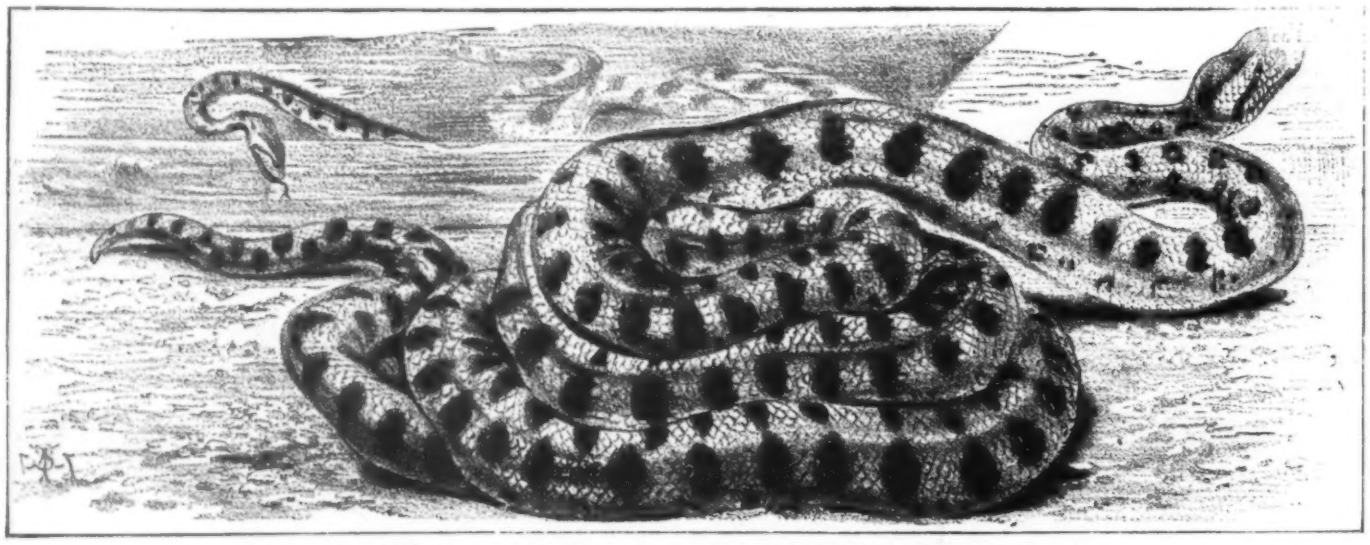
(To be continued.)

* Cæsar mentions this animal, "Urus," as plentiful in the Hercynian forests, but does not refer to its presence in Britain.—ED.

† The American Bison has fifteen pairs of ribs, while the European has fourteen. As regards the Aurochs, no fossil skeleton has been found sufficiently perfect to show the exact number of ribs it possessed.—ED.

‡ In a curious Irish MS. of the ninth century wild oxen are spoken of as inhabiting the county of Clare.—*A. L. A.*

* Many of these cuts are small, and may have been produced by blows from the narrow bronze hatchets (celts) plentifully discovered throughout the country.—*A. L. A.*



THE ANACONDA LATELY RECEIVED AT THE ZOOLOGICAL GARDENS, LONDON.

THE ANACONDA

Is the latest addition to the collection at the Zoological Gardens, having been received at Regent's Park the latter end of February from South America. He is one of the largest of the *Boaidæ* family known to the present generation. He is an anaconda (*Eunectes murinus*), which, translated, means "the good swimming mouse or deer eater." The anaconda has not poisonous teeth, but has great and dangerous powers of crushing, treating a bear as one would a wisp of straw. The box with the snake weighed over 2cwt. This particular specimen is estimated to measure between 18ft. and 20ft. from the tip of his nose to his tail (it being rather a difficult matter to get at the exact length), and about two feet round the body. The anaconda is nocturnal and aquatic in his habits, and, like our own British snake, is found in marshy, damp places, feeding upon animals which come down to drink at night. It has been ascertained that the last meal this snake had previous to capture consisted of a young peccary, the horny part of the hoofs having been discovered in the stones at the bottom of the cage; there are also the hairs of another animal which has to be diagnosed by microscopists. This tropical American snake is also called the Aboma. The provincial name is *El traga venado*, or the deer swallower. He never interferes with men, although, of course, will take his own part if attacked. Shortly after his arrival at the Gardens the anaconda succeeded in forcing out the whole front of its resting place, and would doubtless have been at large but for the timely arrival of Holland, the reptile keeper. Owing to its having been shedding its skin, this snake has only recently been seen by the public. The color may be described as buff, with dark markings on the upper part.—*Pictorial World.*

* Cavan and Waterford.